88th Congress, 2d Session House Document No. 353

COASTS OF THE HAWAIIAN ISLANDS

LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED MAY 15, 1964, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON AN INTERIM SURVEY OF THE COASTS OF THE HAWAIIAN ISLANDS, AUTHORIZED BY THE RIVER AND HARBOR ACT APPROVED MAY 17, 1950

AUGUST 19, 1964.—Referred to the Committee on Public Works and ordered to be printed with three illustrations

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1964

36-957 O

CONTENTS

APPENDIXES ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER
(Only Appendix D printed)

ILLUSTRATIONS ACCOMPANYING THE REPORT OF THE DISTRICT ENGINEER
(Only Plates 7, 8, and 9 printed)

LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C.

IN REPLY REFER TO:

August 15, 1964

Honorable John W. McCormack

Speaker of the House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 15 May 1964, from the Chief of Engineers, Department of the Army, together with accompanying papers and illustrations, on an interim survey of the Coasts of the Hawaiian Islands, authorized by the River and Harbor Act approved 17 May 1950.

The views of the State of Hawaii, the Department of the Interior and the Public Health Service, together with pertinent replies of the Chief of Engineers are inclosed.

The Bureau of the Budget advises that there is no objection to the submission of the proposed report to the Congress; however, it states that no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the projects, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

1 Incl
Report

STEPHEN AILES
Secretary of the Army

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON, D.C. 20503

July 28, 1964

Honorable Stephen Ailes
Secretary of the Army
Washington, D. C. 20310

Dear Mr. Secretary:

Mr. McPherson's letter of July 15, 1964, submitted the favorable report of the Chief of Engineers on a survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels, in partial response to an item in Section 110 of the River and Harbor Act approved May 17, 1950.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the proposed report to the Congress. No commitment, however, can be made at this time as to when any estimate of appropriation would be submitted for construction of the projects, if authorized by the Congress, since this would be governed by the President's budgetary objectives as determined by the then prevailing fiscal situation.

Sincerely yours,

Carl H. Schwartz, Jr.
Chief, Resources and
Civil Works Division

COMMENTS OF THE STATE OF HAWAII

JOHN A. BURNS
GOVERNOR

FUJIO MATSUDA
DIRECTOR

KAIPO F. KAUKA
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL ST., HONOLULU 13, HAWAII

HAR-E
1242

January 31, 1964

Lt. Gen. W. K. Wilson, Jr.
Chief of Engineers
Headquarters
DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington 25, D. C.

Dear Sir:

Subject: Interim Survey of the Coasts of the Hawaiian Islands

We thank you for your letter of January 15, 1964, ENGCW-PD, together with a copy of your proposed report on an interim survey of the Coasts of the Hawaiian Islands, which you are intending to submit to Congress in the very near future.

We are very grateful for this opportunity to review and comment on this report. We do concur in the general scheme of planning as shown. However, we would like to reiterate our comments made in our letter of February 2, 1963, concerning the preliminary plans submitted to us by the District Engineers. At that time, we had recommended a minimum 20-foot entrance channel depth for the following small boat harbors:

WAIANAE, OAHU (Kaneilio Point)
MAUNALUA BAY, OAHU
HANALEI BAY, KAUAI
HANA, MAUI
LAHAINA, MAUI

We note that the depths as shown in the report are as follows:

WAIANAE, OAHU - 17 feet
MAUNALUA BAY, OAHU - 20 feet
HANALEI, KAUAI - 15 feet
HANA, MAUI - 17 feet
LAHAINA, MAUI - 20 feet

The concensus of the boat and yacht owners is that the 20-foot depth is important and necessary in view of the fact that the locations of the five small boat harbors under consideration make them ideal as havens of refuge for light-draft vessels in time of storm.

As requested, we have attached a copy of the letter from the U. S. Fish and Wildlife, also, the favorable views and comments of the State Fish and Game Division.

At this time we would like to comment briefly on Honokahau Small Boat Harbor. The special report on its survey, we understand, is presently being reviewed by the Board of Engineers for Rivers and Harbors. With a view to boosting the economy of the entire Kona area and of the State, we would like to see this project expedited. Your effort directed toward making the Honokahau Small Boat Harbor a reality in the near future would be greatly appreciated.

We thank you again for your keen interest and your effort directed toward the development of harbors for light-draft vessels in Hawaii. We certainly are grateful of the fine cooperative spirit of the Federal government as exemplified by you and the District and Division Engineers.

Very truly yours,

MELVIN E. LEPINE
Chief, Harbors Division

Enclosure

CABLE ADDRESS
FISHWILD

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
P. O. Box 3830, HONOLULU, HAWAII 96812

HAWAII AREA

ADDRESS ONLY
THE AREA DIRECTOR

January 29, 1964

Mr. Melvin E. Lepine
Chief, Harbors Division
State of Hawaii Department
of Transportation
869 Punchbowl Street,
Honolulu, Hawaii

Dear Mr. Lepine:

We have reviewed our letter-report made to the District Engineer of the U.S. Army Corps of Engineers dated June 25, 1962, with reference to the preliminary plans for the nine small-boat harbors to be located along the coasts of the Hawaiian Islands This report was made in consultation with the State of Hawaii Fish and Game Division.

Our views today are essentially unchanged, in that the proposed projects will very likely improve the habitats for the fish fauna. At any rate, the advantages that will accrue from these projects will far outweigh any possible disadvantages.

We hope that this letter will fully meet your requirements.

Very truly yours,

John C. Marr
Area Director

LETTER TO THE STATE OF HAWAII

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO
ENGCW-PD

10 March 1964

Mr. Melvin E. Lepine
Chief, Harbors Division
Department of Transportation
Honolulu, Hawaii

Dear Mr. Lepine:

Reference is made to your letter of 31 January 1964, with inclosure, furnishing the views of the State of Hawaii on the proposed report of the Chief of Engineers on the Coasts of Hawaiian Islands.

With regard to the entrance channel depths for the eight recommended harbors, these depths were selected on an individual basis rather than an over-all fixed criteria because different conditions exist at each site. Each of the eight harbors will protect berthed craft from storm waves. However, the entrance channel for any small-boat harbor constructed in Hawaiian waters which would be exposed to wave action would not be negotiable during storm periods. Additional depth in the entrance channel still would not permit vessels to negotiate safely the entrance channel during these times.

Of the five harbors mentioned in your letter, you indicate that three, Hana, Hanalei, and Waianae do not meet your recommendation of providing for a depth of 20 feet in the entrance channels. Within Hana Bay, existing depths are adequate to meet the draft requirements of small craft and commercial tugs and barges of the type expected to use the harbor so that no initial dredging would be required at the project. A minimum depth of 18 feet exists in the natural entrance channel in the vicinity of the head of the proposed breakwater and the proposed barge pier. However, some dredging in this area probably will be necessary to maintain a minimum project depth of 17 feet. This project depth is considered adequate to meet the draft requirements of small boats and commercial tugs and barges of the type expected to use the entrance channel.

The entrance to Hanalei is protected by a reef area north of the harbor. Our studies indicate that waves would diverge in the vicinity of the entrance channel and, under the most critical conditions, waves of about five feet could be expected at the seaward end of the channel. These waves would not break in a depth of 15 feet. It is considered, therefore, that additional depth in the entrance channel is not needed.

Our studies at Waianae indicate that wave action about 600 feet from the seaward end of the entrance channel would be much greater than in the recommended channel. Vessels which could negotiate this area safely would be able to enter the harbor without too much difficulty.

I wish to assure you that careful consideration has been given to providing adequate depths in the entrance channels.

Sincerely yours,

(Signed)

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF THE INTERIOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

April 24, 1964

Dear General Wilson:

This is in reply to your letter of January 15, 1964, requesting our comments on an interim survey of the coasts of the Hawaiian Islands.

The United States Fish and Wildlife Service advises that the proposed developments will benefit the commercial and sport fisheries of the project areas.

The Regional Director, Western Region, National Park Service, 180 New Montgomery Street, San Francisco, California, 94105, should be kept advised as to progress on the project in order to program and initiate such surveys, salvage, and preservation of historical and archeological evidence as may exist in accordance with provisions of the Act of June 27, 1960 (74 Stat. 220).

One important omission seems to be a failure to consider the tsunami phenomenon in computing wave heights. You may wish to consider this matter in further review of the report.

We appreciate the opportunity of presenting our comments.

Sincerely yours,

Kenneth Holum
Assistant Secretary of the Interior

Lt. General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

LETTER TO THE SECRETARY OF THE INTERIOR

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20315

IN REPLY REFER TO
ENGCW-PD

14 May 1964

The Honorable Stewart L. Udall

The Secretary of the Interior

Dear Mr. Secretary:

Reference is made to the letter of 24 April 1964 from the Assistant Secretary of the Interior commenting on the proposed report of the Chief of Engineers on the Coasts of the Hawaiian Islands.

With regard to consideration of the tsunami phenomenon in computing wave heights, it has been determined that it would not be feasible to provide protection for these harbors against such waves. However, special consideration was given to the problem of emergency evacuation of the harbors during tsunami warnings which occur from time to time. In the case of those projects which would involve several hundred harbor based craft, congestion of the channels during a rapid evacuation would be critical and, therefore, additional width allowances have been made for such situations.

Sincerely yours,

(Signed)

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

COMMENTS OF THE PUBLIC HEALTH SERVICE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE — WASHINGTON 25, D. C.

BUREAU OF STATE SERVICES

Refer to:

April 10, 1964

Lieutenant General Walter K. Wilson, Jr.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Wilson:

This is in reply to your letter of January 15, 1964, requesting comments on the U. S. Army Engineers' Report on an Interim Survey of the Coasts of the Hawaiian Islands.

Our San Francisco Regional Office commented on this project in July 1962, pointing out the need for relocation of the existing outfall sewer at Waianae, Oahu. We have been assured that the relocation will be made, and that the plan is completely acceptable to the Hawaii Department of Health. We do not foresee any other problems involving pollution control.

It is suggested that the Hawaii Department of Health be consulted on necessary vector control procedures during construction of the improvements.

The opportunity to review this report is appreciated. We stand ready to supply further consultation on your request.

Sincerely yours,

James B. Coulter

James B. Coulter
Acting Chief
Technical Services Branch
Division of Water Supply
and Pollution Control

COASTS OF THE HAWAIIAN ISLANDS

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D.C.

IN REPLY REFER TO

ENGCW-PD

15 May 1964

SUBJECT: Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels

TO: THE SECRETARY OF THE ARMY

1. I submit for transmission to Congress my report on a survey of the Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels, in partial response to an item in the River and Harbor Act approved 17 May 1950 authorizing a preliminary examination and survey of the coasts of the Hawaiian Islands with a view to the establishment of harbors for light-draft vessels for refuge and other purposes. My report includes the reports of the District and Division Engineers and the Board of Engineers for Rivers and Harbors. A final report under the authorization will be submitted later.

2. The District Engineer recommends provision of harbors for light-draft vessels, principally recreational craft, at eight sites: Hanalei Bay on the island of Kauai; Waianae, Heeia-Kea, Kailua and Maunalua Bay on the island of Oahu; Lahaina and Hana on the island of Maui; and Reeds Bay (Hilo) on the island of Hawaii; subject to certain items of local cooperation including cash contributions. The proposed improvements are economically justified. The Division Engineer concurs in the overall plan but recommends that the Heeia-Kea Harbor be constructed in two stages, the second stage consisting of the north basin to be deferred until the need becomes apparent.

3. The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. It notes that construction of the small-boat facilities at Kailua, Oahu, will require modification of the authorized flood-control project for Kawainui Swamp to permit unrestricted access to the ocean, except for limitations imposed by the bridge over the existing canal. The Board believes that construction of the Heeia-Kea Harbor should be accomplished in two stages, as proposed by the

Division Engineer. The Board recommends the proposed improvements substantially in accordance with the plans of the District Engineer as modified by the Division Engineer to include two-stage construction of Heeia-Kea Harbor, at an estimated construction cost for the eight projects of $7,801,000, subject to local cooperation including cash contributions presently estimated at $3,064,000 toward the first costs of construction. The estimated net cost to the United States is $4,737,000 for construction and $58,000 annually for maintenance.

4. I concur in the recommendations of the Board.

W. K. WILSON, JR.
Lieutenant General, USA
Chief of Engineers

ENGBR(8 Mar 63) 2nd Ind
SUBJECT: Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels

Board of Engineers for Rivers and Harbors, Washington, D. C. 20315
21 November 1963

TO: Chief of Engineers, Department of the Army

1. The Hawaiian Islands are part of a volcanic mountain range, most of which is submerged. The island of Hawaii, the largest of the group, is the only one which remains actively volcanic. The general ocean depths prevailing adjacent to the island chain are about 15,000 feet. The coastlines of the islands vary greatly in physical character. Cliffs rise sheer from the sea to heights of over 1,000 feet along the northwest coast of Kauai and the north coast of Molokai, and lower cliffs prevail along much of the coast of Hawaii. In contrast, low-lying coasts with sweeping beaches are found on Maui, Oahu, and Kauai. Other types of shoreline include low areas fringed by offshore coral reefs; and low, rocky coasts with occasional small pocket beaches or interrupted by bold headlands. The main islands are separated by broad windswept channels, the widest of which is about 73 miles between Kauai and Oahu, and the others ranging in width between 6 and 30 miles. Fair weather predominates throughout the year, but strong gusty winds and local rain squalls cause difficult to dangerous sea conditions for small craft much of the time along coasts exposed to the prevailing northeasterly trade winds and in the unsheltered interisland channels. Major storms consist of low pressure troughs, known locally as "kona" storms because they ordinarily bring winds from the south; cold fronts with northerly winds; and hurricanes of infrequent occurrence. Normal tidal fluctuations generally do not exceed 2 feet, with a mean range of 1.5 feet. However, the islands are subject to "tsunami", or seismic-generated waves, which cause severe damage to coastal developments.

2. There are no Federal navigation improvements in Hawaii specifically for the use of small boats. There are seven Federally improved commercial harbors, six of which are 35 feet deep and one 23 feet deep. The harbors with 35-foot depth are Port Allen and Nawiliwili Harbors on Kauai, Honolulu Harbor on Oahu, Kahului Harbor on Maui, and Hilo and Kawaihae Harbors on Hawaii; the 23-foot harbor is at Kaunakakai on Molokai. The local government has been very active in developing sites for recreational craft, particularly in the vicinity of Honolulu. There are 20 harbors for small boats along the shores of the islands, 15 owned by the State, and 5 by private interests, with mooring space for 2,160 boats.

36-957 O-64—2

3. Traditionally, the basic industry of the islands has been agriculture, primarily sugar and pineapple production. Production of beef, dairy and poultry products, and coffee have been leading secondary industries. At present, activities of the Federal Government represent a major source of income for the State, with construction resulting from an acute housing and building shortage following World War II also of major importance. The tourist industry has been increasing steadily and is generally considered the major growth force influencing both the present and future economy of the State. Commercial fishing is of only local economic importance. Fishing is a year-round activity but the bulk of the skipjack or tuna catch, which comprises about 80 percent of the total commercial fish catch, is made generally during the spring and summer seasons from April through August. The total recorded commercial fish catch in Hawaii in 1960 was over 11 million pounds valued at $2.7 million. Recreational fishing is extremely popular but no statistics are available regarding the volume of fish caught. In 1961 there were about 530 commercial fishing boats and 5,400 other small craft (mainly recreational) operating in the islands.

4. Local interests desire improvement of certain existing harbors and provision of new harbors to accommodate the growing recreational fleet and provide improved facilities for the commercial fishing fleet. Improvement of 45 sites is desired. Also requested is a system of harbors located at or near the closer points of each of the main islands for possible use of a future roll-on roll-off ferry system. Local interests state that for many years there has been an acute shortage of small-boat harbors which impedes the growth of recreational boating activities and denies safe harbors for the protection of life and property.

5. The District Engineer considered it necessary to formulate a basic statewide plan for small-boat harbor development to relate the individual local projects to the total light-draft navigation needs of the State. He finds that in order to meet the immediate demand for harbor space it would be necessary to expand and improve 7 existing harbors and construct 12 new harbors at unimproved sites. Capacity for 7,000 boats would be provided, which would satisfy the bulk of the requirements through 1975. Six of the 19 harbors would be financed by the State since 3 were constructed in 1962 and 3 others are being actively planned by the State; 4 are under study by the District Engineer for accomplishment under authority of Section 107 of the River and Harbor Act of 1960; 1 has already been authorized by the River and Harbor Act of 1962; and 8, with a capacity of about 4,300 boats, are recommended in this report. A subsequent report will consider additional harbors for refuge purposes and harbors for a possible roll-on roll-off ferry system.

6. The District Engineer finds that the most feasible plans of improvement for the eight harbors for which there is immediate need are as follows:

Location	Recommended improvement
Hanalei Bay Kauai	An entrance and main access channel 1,800 feet long, 100 feet to 120 feet wide, 12 feet to 15 feet deep; a jetty 380 feet long; and 1,600 feet of channel and bank revetment.
Waianae Oahu	A breakwater 1,350 feet long; a groin 175 feet long; an entrance channel 830 feet long, 150 feet wide, depth 15 feet to 17 feet; a main access channel 870 feet long, 100 feet to 150 feet wide, 12 feet to 15 feet deep.
Heeia-Kea Oahu	Three revetted moles with lengths of 1,450 feet, 1,780 feet, and 1,720 feet; a north access channel 570 feet long, 150 feet wide, and 12 feet deep; a central access channel 1,100 feet long, 200 feet wide and 12 feet deep; a south access channel 150 feet long, 150 feet to 280 feet wide, and 8 feet deep; plus removal of coral head.
Kailua Oahu	A turning basin of 120,000 square feet, 6 feet deep; and a main access channel 1,800 feet long, 100 feet to 150 feet wide, and 6 feet deep.
Maunalua Bay Oahu	An east revetted mole 2,900 feet long; a west revetted mole 1,950 feet long; an entrance channel 870 feet long, 200 feet wide, 15 feet to 20 feet deep; a widened channel section of 370,000 square feet, 15 feet deep.
Lahaina Maui	A revetted mole 620 feet long; offshore breakwater 950 feet long; turning basin and main access channel of 140,000 square feet; entrance channel 515 feet long, 150 feet wide, 15 feet to 20 feet deep; and a wave absorber 180 feet long.
Hana, Maui	A breakwater 1,230 feet long.
Reeds Bay (Hilo) Hawaii	A breakwater 870 feet long; and entrance channel 880 feet long, 120 feet wide, and 12 feet deep.

7. The estimated first costs, annual charges and benefits, and the benefit-cost ratios for the proposed improvements, prepared by the District Engineer, are shown in Table I. The first costs are based on November 1962 prices and the benefit-cost ratios are for a 50-year period of analysis. The benefits from the proposed works would result from increased utilization of existing recreational boats, additions to the present recreational fleet, increased fish catch by the commercial fishing fleet, savings in commercial transportation between Honolulu and Hana Harbors, reduction of vessel damage for all types of small craft using the coastal waters of the islands, and land enhancement. About 84 percent of the total benefits for the 8 harbors recommended would accrue to recreational craft, 2 percent to commercial fishing, 10 percent to commercial transportation, and 4 percent to land enhancement resulting from use of dredged material for land fill. The District Engineer recommends the harbor improvements in accordance with his plans subject to local cooperation, including cash contributions as specified. The Division Engineer concurs in the overall plan but recommends that the Heeia-Kea Harbor be constructed in two stages, the second stage consisting of the north basin to be deferred until the need becomes apparent.

TABLE I

Project	First Costs (In Thousands of Dollars)								Annual charges (3)	Annual benefits	B/C
	Federal			Non-Federal							
	Construction (1)	Aids to navigation	Total (1) (2)	Lands	Relocations	Cash contribution	Total	Total	($1,000)		
Island of Kauai											
Hanalei Bay	$ 347	$10	$ 357	$208	$ -	$ 322	$ 530	$ 887	$ 36.5	$ 47.1	1.3
Island of Oahu											
Waianae	933	10	943	65	8	861	934	1,877	85.0	96.1	1.1
Heeia-Kea	409	5	414	38	-	399	437	851	38.1	211.3	5.5
Kailua	244	6	250	242	-	243	485	735	34.6	52.7	1.5
Maunalua Bay	513	18	531	147	-	510	657	1,188	54.6	232.2	4.2
Island of Maui											
Lahaina	364	13	377	23	-	321	344	721	32.9	47.4	1.4
Hana	1,679	16	1,695	29	-	160	189	1,884	88.2	107.1	1.2
Island of Hawaii											
Reeds Bay (Hilo)	248	9	257	26	-	248	274	531	24.6	53.3	2.2
Total	$4,737	$87	$4,824	$778	$ 8	$3,064	$3,850	$8,674	$394.5	$847.2	2.1

(1) Total first cost of construction less the non-Federal cash contribution.

(2) Exclusive of preauthorization study costs.

(3) Includes annual maintenance: Hanalei Bay $2,000, Waianae $12,000, Heeia-Kea $5,000, Kailua $6,000, Maunalua Bay $8,500, Lahaina $5,000, Hana $15,000 and Reeds Bay $4,000. Total $58,000.

8. The Division Engineer issued a public notice stating the recommendations of the reporting officers and affording interested parties an opportunity to present additional information to the Board. Careful consideration has been given to the communications received.

Views and Recommendations of the Board of Engineers for Rivers and Harbors.

9. Views.--The Board of Engineers for Rivers and Harbors concurs in general in the views and recommendations of the reporting officers. The Board notes that the need for small-boat navigation improvements has been approached on a statewide basis with a view to developing an adequate harbor system for the major islands. It notes further that the eight harbors recommended by the reporting officers are in addition to six to be improved by the State and four which are under study for accomplishment under authority of Section 107 of the River and Harbor Act of 1960, and are considered urgent. A final report treating the need for harbors intended exclusively for refuge purposes, harbors for possible roll-on roll-off ferry service, and additional harbors to satisfy the recreational boating needs to the year 2015, will be submitted at a later date. The Board notes also that construction of the small-boat facilities at Kailua, Oahu, will require modification of the authorized flood-control project for Kawainui Swamp to permit unrestricted access to the ocean, except for limitations imposed by the bridge over the existing canal. The Board believes that construction of the Heeia-Kea Harbor should be accomplished in two stages, as proposed by the Division Engineer. The Board considers that the harbors recommended are economically justified and the requirements of local cooperation are appropriate.

10. Recommendations.--Accordingly, the Board recommends improvement of harbors for light-draft vessels at Hanalei Bay, Kauai; Waianae, Heeia-Kea, Kailua, and Maunalua Bay, Oahu; Lahaina and Hana, Maui; and Reeds Bay (Hilo), Hawaii; generally in accordance with the plans of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated cost for the eight projects of $7,801,000 for construction and $58,000 annually for maintenance: Provided that prior to construction of each project local interests agree to:

a. Contribute in cash a part of the first cost of construction of the general navigation facilities comprising breakwaters, protective moles, and entrance and access channels, to be paid in a

lump sum prior to initiation of construction, subject to final adjustment after actual costs have been determined, as follows:

Location	Construction cost	Local cash contribution	
		Percent	Present estimate
Hanalei Bay, Kauai	$ 669,000	48.1	$ 322,000
Waianae, Oahu	1,794,000	48.0	861,000
Heeia-Kea, Oahu	808,000	49.4	399,000
Kailua, Oahu	487,000	50.0	243,000
Maunalua Bay, Oahu	1,023,000	49.9	510,000
Lahaina, Maui	685,000	46.9	321,000
Hana, Maui	1,839,000	8.7	160,000
Reeds Bay, Hawaii	496,000	50.0	248,000
Total	$7,801,000	39.3	$3,064,000

b. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the projects and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for the initial and subsequent disposal of spoil, and also provide necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works;

c. Provide and maintain without cost to the United States necessary berthing or mooring facilities and attendant utilities, including a public landing with suitable supply facilities open to all on equal terms, and additionally at Hana, Maui, provide and maintain an appropriate public terminal with essential facilities for commercial use;

d. Provide and maintain without cost to the United States depths in the berthing and mooring areas, and in the local access channels, commensurate with the depths provided in the related project areas;

e. Provide and maintain without cost to the United States all appropriate onshore structures, access roads, parking areas, public rest rooms, and boat-launching ramps as necessary to insure a complete and adequate project; and

f. Accomplish without cost to the United States such utility, drainage, or other relocations or alterations as necessary.

Provided further that construction of any of the individual projects recommended for authorization may be undertaken independently of the others whenever the necessary funds therefor become available and when local interests have agreed to furnish the required local cooperation, but that construction of any of the individual projects will not be construed as a commitment on the part of the Federal Government nor the responsible non-Federal interests for construction of the remaining projects.

It is further recommended that:

Construction of the Heeia-Kea Harbor be accomplished in two stages, the second stage consisting of the revetted mole and main access channel of the north basin to be deferred until the need therefor becomes apparent; and

Construction of Kailua Harbor, Oahu, be contingent upon construction of the authorized flood-control channel to Kawainui Swamp with modifications adequate to provide a suitable access channel to the small-boat harbor.

The net first and annual maintenance costs to the United States, excluding costs of aids to navigation and after payment by local interests of the amounts indicated above, are now estimated as follows:

ENGBR(8 Mar 63)
SUBJECT: Coasts of the Hawaiian Islands, Harbors for Light-Draft Vessels

Project	First cost	Annual maintenance
Hanalei Harbor, Kauai	$ 347,000	$ 2,000
Waianae Harbor, Oahu	933,000	12,000
Heeia-Kea Harbor, Oahu	409,000	5,000
Kailua Harbor, Oahu	244,000	6,000
Maunalua Harbor, Oahu	513,000	9,000
Lahaina Harbor, Maui	364,000	5,000
Hana Harbor, Maui	1,679,000	15,000
Reeds Bay Harbor, Hawaii	248,000	4,000
Total	$4,737,000	$58,000

FOR THE BOARD:

R. G. MacDONNELL
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

SYLLABUS

The district engineer finds that the available harbors for small craft in the State of Hawaii are presently able to accommodate less than half of the public demand for safe berthing space for water based boats, and that the existing improved harbors are unfavorably distributed, in the strategic sense, among the major islands and inequitably located in terms of local needs. He further finds that the over-all inadequacy of the developed harbor facilities has adversely affected commercial fishing operations and retarded the growth rate of recreational boating. Monetary losses from damages to the existing small craft fleet, attributable to inadequate harbor protection and lack of satisfactory facilities, are estimated to total more than $275,000 per annum. Consequently, he concludes that Federal participation with the State Government in developing an improved and expanded system of boat harbors to meet the present and forthcoming requirements of the people of Hawaii is warranted and desirable in the public interest.

Therefore, the district engineer recommends Federal adoption at this time of eight separate light-draft vessel navigation projects, subject to the conditions of local cooperation specified in the report, to include construction and maintenance of the general navigation channels, maneuvering areas, and protective structures identified in the report and on the accompanying general plans. The estimated costs and economic justification of these small boat harbors and the recommended locations thereof are as follows:

Project location	Federal construction cost[1/]	Federal maintenance cost (annual)	Non-Federal cost[2/]	Benefit-cost ratio
Island of Kauai:				
Hanalei Bay	$ 347,000	$ 2,000	$530,000	1.3 to 1
Island of Oahu:				
Waianae	933,000	12,000	934,000	1.1 to 1
Heeia-Kea	409,000	5,000	437,000	5.5 to 1
Kailua	243,500	6,000	485,500	1.5 to 1
Maunalua Bay	513,000	8,500	657,000	4.2 to 1
Island of Maui:				
Lahaina	364,000	5,000	344,000	1.4 to 1
Hana	1,679,000	15,000	189,000	1.2 to 1
Island of Hawaii:				
Reeds Bay (Hilo)	248,000	4,000	274,000	2.2 to 1

1/ Exclusive of aids to navigation.
2/ Exclusive of self-liquidated facilities.

U. S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS
BLDG. 96, FT. ARMSTRONG
HONOLULU 13, HAWAII

POHGP 8 March 1963

SUBJECT: Interim Report on Survey of the Coasts of the Hawaiian Islands for Harbors for Light-draft Vessels

TO: Division Engineer
U. S. Army Engineer Division, Pacific Ocean
Honolulu, Hawaii

INTRODUCTION

1. AUTHORITY

This report is submitted in partial compliance with section 110 of the River and Harbor Act of 17 May 1950, the pertinent portions of which are quoted below:

> "Sec. 110. The Secretary of the Army is hereby authorized and directed to cause preliminary examinations and surveys to be made at the following-named localities, the cost thereof to be paid from appropriations heretofore or hereafter made for such purposes: * * * * *
> Coasts of the Hawaiian Islands with a view to the establishment of harbors for light-draft vessels for refuge and other purposes * * * * * "

Before the preliminary examination was completed, the River and Harbor Act of 3 July 1958 directed that preliminary examination reports be discontinued; and that investigations and reports for navigation and allied purposes be prepared under the supervision of the Chief of Engineers in the form of survey reports.

2. PURPOSE AND SCOPE OF STUDY

The investigations undertaken in this survey to determine the need and advisability of Federal construction at this time of harbors for small boats in the Hawaiian Islands were limited to the coastlines of the six major islands of Kauai, Oahu, Molokai, Lanai, Maui, and Hawaii. Privately-owned Niihau, which had 254 inhabitants in 1960, is closed to public access and was excluded from the survey. The

problem of determining existing and forthcoming needs for light-draft navigation improvements in Hawaii and the justification for Federal projects has been approached from the comprehensive planning point of view on a statewide basis. Potential Federal projects should be effectively related to State programs and private developments so that all existing and forthcoming boat harbors will fit into a coordinated system aimed at accomplishing the best overall results for the least cost. Thus, the objectives of the survey are to determine the State's requirements for light-draft harbors, to present a basic plan for an adequate harbor system which will satisfy the requirements, and to recommend the extent of Federal participation deemed advisable in establishing such a harbor system. The purpose of this interim report is to show the current and projected requirements over the next 50 years for light-draft harbor space throughout the State as a whole, to present a plan for a harbor system initially limited to those harbors now considered most urgently needed, and to recommend adoption of Federal projects at this time within the system. The final report of the survey will treat the need for harbors intended exclusively for refuge purposes and analyze remaining requirements for additional harbors to satisfy the State's total small-craft needs to the year 2015.

Extensive studies of both a general and technical nature were undertaken during the course of this survey. The work included office compilation and analysis, field reconnaissance, hydrographic and topographic site surveys, subsurface explorations, field inventories of existing craft and harbor facilities, interviews with many knowledgeable persons in the boating and fishing fields, and consultations with the State and Federal agencies concerned with Hawaiian water resources development, fish and wildlife, land use, transportation, and planning. Map, chart, and photographic sources were fully utilized and many new photographs were taken for use in site analysis and wave studies. Comprehensive economic analyses were made in the preparation of the economic base study of Hawaii. Land use and value, real property ownership, accessibility, and local economic activity were studied in detail for each harbor site, as well as the potential benefits and costs.

The Harbors Division, Department of Transportation, State of Hawaii, substantially assisted the district engineer in the accomplishment of this survey by conducting complementary and supplementary research. Their reports titled "Recreational Boating in Hawaii" dated July 1961 and "Commercial Fishing Boat Operation in Hawaii" dated August 1961 were extensively used in this study. Other State reports furnished relevant information on existing interisland water commerce and the proposed interisland ferry system. Feasibility studies prepared on five harbor sites by private consultants for the State were also of valuable assistance in the compilation of this report. The Harbors Division has cooperated to the fullest degree in providing supporting material and advice and has also formulated a separate State program of small-boat harbor construction to supplement the Federal contribution in the form of this survey and subsequent Federal projects.

Other local governmental agencies, navigation companies, business and civic organizations, boat associations and other knowledgeable parties were consultees for information, data and views. A total of 12 public hearings were held to enable local interests to present their views.

3. PRIOR REPORTS

A recent review report on survey for navigation improvements at Kaunakakai Harbor recommended Federal expansion of the existing barge harbor into a deep-draft harbor to accommodate transpacific vessels and, in conjunction therewith, Federal construction of a separate light-draft harbor that could eventually accommodate approximately 225 small craft. This project was authorized by the River and Harbor Act of 1962 and is described in House Document No. 484, 87th Congress, 2d session.

Four of the urgently needed small-boat harbors discussed in this report are being studied under Section 107 of the River and Harbor Act of 1960, which provides for construction of small navigation projects under the discretionary authority of the Chief of Engineers. These harbors are Maalaea, Maui; Haleiwa, Oahu; Manale, Lanai; and Nawiliwili, Kauai.

4. EXISTING CORPS OF ENGINEERS' PROJECTS

There are no Federal navigation improvements in Hawaii exclusively for the use of light-draft vessels. Of the 7 Federally-maintained harbors, 6 are deep-draft projects with basin depths of 35 feet; 1 is a medium-draft barge harbor with a depth of 23 feet. All of these Federal harbors are available for the refuge of transient small craft and for use as a base of operations by local boats. Although no requirements for small-craft facilities were stipulated in the prescribed conditions of local cooperation in the authorizing documents for those deep-draft harbors, except Kaunakakai Harbor, the State has independently provided limited facilities for light-draft vessels at these harbors. Only about 250 of the approximate 6,000 small craft in the State, however, are based at shore points within the sheltered area provided by the existing Federal projects. The State desires to separate recreational boating and fishing activity from the commercial shipping areas of the deepwater ports as much as practicable in the future.

DESCRIPTION

5. TRIBUTARY AREA

a. General. The entire populated portions of the main islands of the State of Hawaii would comprise the overall tributary area of the urgently-needed harbor system proposed in section 12 of this report. Hawaii, the 50th and most recent state of the Union, ranks 47th in size and 43rd in population. Its 1960 population was 632,722; its total land area is 6,415 square miles, slightly larger than Connecticut and

Rhode Island combined. Hawaii's fragmented, insular character, its subtropical climate, and its remote, mid-ocean location make it geographically unique among the states. Honolulu, the capital, is 2,406 miles from San Francisco, 2,564 miles from Los Angeles, and 2,772 miles from Seattle. The Hawaiian Archipelago, under the jurisdiction of the State except for Midway Island, extends over some 1,500 nautical miles of the North Pacific Ocean and consists of a series of mountaintop islands, islets, pinnacles, and reefs, all rising thousands of feet from the ocean floor.

The 8 principal islands form a 400-mile arc at the southeastern end of the archipelago and comprise over 99 percent of the State's land area. Of these, Kahoolawe is barren and uninhabited; Niihau is privately-owned and little developed. Both are small. The other six islands constitute the heartland of the State. Their relative size, population, and economic status are compared in table 1, which shows that Oahu, only fourth in size of the main islands, completely dominates the others in terms of development and human activity.

Table 1

Comparative Statistics for Hawaii's
Six Major Islands (1960)

Island	Kauai	Oahu	Molokai[1/]	Lanai[1/]	Maui	Hawaii
Area (sq. miles)	625	604	259	141	728	4,030
Percent of total	9.7	9.4	4.2	2.2	11.3	62.6
Population[2/]	27,922	500,409	5,023	2,115	35,717	61,332
Percent of total	4.4	79.1	0.8	0.3	5.6	9.7
Retail trade (millions)	$25.8	$735.8	-	-	$40.3	$56.7
Percent of total	3.0	85.7	-	-	4.7	6.6
Agriculture (millions)	$41.5	$109.4	-	-	$76.9	$60.7
Percent of total	14.4	37.9	-	-	26.7	21.0
Manufacturing (millions)	$1.4	$136.2	-	-	$2.8	$8.3
Percent of total	0.9	91.6	-	-	1.9	5.6
Tourist expenditures (millions)	$4.3	$119.6	-	-	$2.4	$4.7
Percent of total	3.3	91.3	-	-	1.8	3.6

1/ Figures on the retail trade, agricultural output, etc., of Molokai and Lanai are included in the figures for Maui, those islands being part of Maui County.

2/ Includes 52,916 military personnel, nearly all of whom are stationed on Oahu.

(Source: Bank of Hawaii, 1961 Annual Economic Report)

b. Population and economic development.

(1) Present and past situation. During the decade 1950-60 the overall rate of economic growth in Hawaii was impressive. Personal income expanded at an average annual rate of about 5.3 percent as compared with a national growth rate of about 3.4 percent. In that 10-year period the population increased approximately 27 percent, rising from 499,794 in 1950 to 632,722 in 1960. Almost all of the growth registered occurred on the island of Oahu. While the other major islands of the State had modest increases in total personal income, they showed a decline in both employment and population. These declines stemmed from a reduction in employment in plantation-type agriculture resulting from increased mechanization as well as from the failure of employment opportunities to significantly expand in other areas of economic activity. In effect, people moved from the "neighbor islands" to seek work on Oahu or on the mainland.

Census data for 1961 indicate that the migration from the other islands has decreased somewhat indicating a tendency toward stabilization although the overall decline in the population of the "neighbor islands" continued. This trend is expected to be reversed in the near future as more people come to Hawaii from the mainland and as potential economic growth in some sectors of the economy begins to be realized, particularly in the tourist industry.

In 1961 Hawaii's economy generated a gross State product of $1.8 billion and a total personal income of $1.5 billion based on a labor force of 239,510. Traditionally Hawaii's basic industry has been agriculture, primarily sugar and pineapple production. Beef, dairy and poultry products, and coffee have been leading secondary industries in the agricultural field, with produce, fruits, and nuts of growing significance. The Federal Government as an industry, however, ranks first in Hawaii both as a source of income and as an employer. Defense expenditures account for about 80 percent of the Federal spending in the State. The construction industry ranked second in overall earnings in 1960, the gross value of construction having risen from $97 million in 1955 to $275 million in 1960. The acute housing and building shortage felt in the islands following World War II is now partially overcome so that the future outlook is for a moderation in the level of construction activity. However, this industry will continue to be a very important element of the economy. The tourist industry also has been steadily climbing in importance to the State, as has diversified manufacturing. Tourism is generally considered the major growth force influencing the economic outlook at the present time. Table 2 contrasts the relative value ranking of the major categories of industry in Hawaii as of 1950 and 1960 and indicates the average annual growth rate for that period in percent.

Table 2

Growth Rate of Major Hawaiian Industries, 1950-60

Category	1950 earnings or value ($ millions)	1960 earnings or value ($ millions)	Average annual growth (percent)
Federal expenditures:			
Defense	147.0	373.0	9.8
Non-military	55.5	110.2	7.1
Construction	67.7	275.4	15.1
Manufacturing	71.6	148.7	7.6
Tourism	24.2	131.0	18.4
Sugar	124.0	127.4	0.3
Pineapple	101.0	118.0	1.6
Other agriculture	27.3	42.7	4.6
Trade:			
Export	230.0	264.0	1.4
Import	363.0	569.0	4.6
Retail	462.6	858.6	6.4
Wholesale	222.8	359.0	4.9

(Source: Bank of Hawaii, 1961 Annual Economic Report)

(2) Projected growth trends. Projections of economic development for the State of Hawaii over the next 50 years envisage an average annual rate of expansion of about 3.2 percent. The major growth force expected to operate most effectively in the continued expansion of the State's basic economy is the tourist industry. With a reasonable exploitation of the State's natural resources, continued development of the tourist plant, and active promotion, this industry should continue to expand at a rate commensurate with its past growth. In making an estimate of growth it is assumed that Federal expenditures would remain at about their present level during coming years.

In the agricultural sector of the economy embracing the production and processing of the export crops - sugar, pineapple, and coffee - there would be a slight growth in the future. These products are now operating in a highly competitive market and prospects for expansion are restricted by high labor and transportation costs and

also by limitations on the availability of suitable additional acreage. As the population of the State grows, however, an increased demand is expected for local agricultural produce that can favorably compete with mainland imports. Thus, the expanded local market would result in the continued moderate growth of diversified farming and livestock production. This segment of the agricultural economy, therefore, would be of particular importance to the neighbor islands where the encroachment of urbanization upon agricultural land is not such a problem as on the island of Oahu.

Projections of personal income and population for the State and its four counties are summarized in table 3.

Table 3

State of Hawaii
Projection of Civilian Population and Personal Income

Civilian Population[1/]

	1960	1965	1980	2010
STATE OF HAWAII	579,856	659,500	876,800	1,261,300
City and County of Honolulu	447,804	521,000	714,700	1,016,000
Kauai County	28,036	30,900	36,600	57,600
Maui County	42,816	45,400	53,700	80,000
Hawaii County	61,200	62,100	71,800	107,700

Total Personal Income
(Millions of constant 1958 dollars)

	1960	1965	1980	2010
STATE OF HAWAII	$1,275	$1,700	$3,000	$6,400
City and County of Honolulu	1,075	1,450	2,600	5,400
Kauai County	45	50	85	210
Maui County	65	85	135	310
Hawaii County	88	110	175	410

1/ Excludes military personnel but includes military dependents.

c. Geography and geomorphology. The Hawaiian Islands are part of a great volcanic mountain range, most of which is submerged. At the highest part of the range, its southeastern portion, a number of large peaks protrude above sea level constituting the major populated islands of the State. The general ocean depth prevailing adjacent to the island chain is about 15,000 feet. Only the island of Hawaii, the largest of the group, remains actively volcanic. It continues to be the world's most spectacular lava-producing area.

36-957 O-64—3

The eight principal islands have been formed by successive flows of basaltic lavas which erupted first from vents in the ocean floor and later from craters and fissures as the lava domes rose above sea level. The island of Hawaii is basically composed of five domes; Maui, Molokai, and Oahu of two each. The islands of Lanai and Kauai each developed from single domes. Peak elevations of lava accumulation are on Hawaii, where Mauna Kea reaches a height of 13,784 feet, and Mauna Loa is almost as high. Maui has the third highest mountain in the islands, Haleakala, with a summit elevation of 10,025 feet. Peak elevations range to approximately 5,000 feet on the other four islands.

Only the three highest and largest mountains retain their dome-like form since they are geologically the youngest. Stream erosion of the other domes and wave action along the coasts greatly modified their surface topography following the era of active volcanism so that today they appear as rugged, irregular mountain masses or ranges. In the wetter, windward areas, steep slopes or precipitous cliffs, sharp ridges, and deeply-incised narrow valleys are characteristic of the mountainous terrain. On the whole, the leeward, drier slopes of the mountains are comparatively less steep and rugged.

In contrast to the mountain lands, only about 20 percent of the total area in the islands is relatively level to gently sloping. Restricted coastal-plain strips are intermittent along the shorelines of the islands. Lowlands or plateau districts are situated between the mountain masses on the islands of Oahu, Molokai, Maui and Hawaii. It is in these areas where the population and economic activity of the State are concentrated.

d. Coastline. The Hawaiian coastline varies greatly in physical character from island to island and from one district to another on each island. The volcanic origin and mountainous nature of the islands, however, result in a predominantly bold and rugged coastline with few naturally protected bays or inlets. Marked contrasts in coastal terrain are a significant factor influencing local boating activities. Inhospitable shoreline features and the consequent lack of developed harbors, sheltered anchorages for refuge from rough weather, and safe landings virtually preclude boating activity along some coastal sectors except by the larger, more powerful craft. For example, towering cliffs rise sheer from the sea to heights of 1,000 feet or more along the northwest coast of Kauai and much of the north coast of Molokai. Lower but similarly precipitous cliffs prevail along the Hamakua coast of Hawaii, northwest of the city of Hilo, and in other areas on Hawaii, Maui, and Lanai. On the other hand, low-lying coasts with sweeping beaches are extensively developed in some areas, particularly on Maui, Oahu, and Kauai.

Another type of shoreline is the low coast fringed by an offshore coral reef. This type occurs extensively along the east and south sides of Oahu, the south coast of Molokai, and the north coast of Lanai. Further variety in the nature of the shoreline is seen in the low, rocky coast with occasional small pocket beaches or the intermittent low shore interrupted by bold headlands.

Table 4 contains mileage figures on the tidal shorelines of the six islands and shows the combined length of high sea cliffs which restrict coastal use and development.

Table 4

Shoreline Data

Island	Length of tidal shoreline (miles)	Sea cliffs over 100 feet high (miles)
Kauai	110	25
Oahu	209	3
Molokai	106	29
Lanai	52	14
Maui	149	29
Hawaii	313	54
Totals	939	154

e. Interisland channels. The main islands of the Hawaiian chain are separated by broad, windswept channels, some of which are relatively more sheltered from the prevailing trade winds than others. The widest channel, between Kauai and Oahu, is about 73 miles across at its narrowest point. The channels between the other islands are considerably narrower, ranging in width between 6 and 30 miles. These channels provide the shipping lanes and boating areas between the islands. Some of them are locally important fishing grounds. Their characteristics are summarized in table 5.

Table 5

Interisland Channels

Name	Location -- separates islands of	Approx. width at narrowest point (miles)	Approximate depth at mid-channel (feet)	Exposure to prevailing trade winds
Kaulakahi	Niihau/Kauai	17	2,500	Partly protected
Kauai	Kauai/Oahu	73	10,000	Exposed
Kaiwi	Oahu/Molokai	26	2,000	Exposed
Kalohi	Molokai/Lanai	9	260	Partly protected
Pailolo	Molokai/Maui	9	800	Exposed
Auau	Lanai/Maui	9	108	Partly protected
Alalakeiki	Maui/Kahoolawe	7	470	Partly protected
Alenuihaha	Maui/Hawaii	29	6,120	Exposed

f. Climate and storm frequency. Fair weather favorable to boating predominates throughout the year in Hawaii, and general storms affecting wide areas are infrequent. However, adverse operating conditions are often experienced along windward coasts and in offshore waters. In fact, strong gusty winds and local rain squalls cause difficult to dangerous sea conditions for small craft much of the time along coasts exposed to the prevailing northeasterly trade winds and in the unsheltered interisland channels. The trade winds predominate about nine months of the year and exert a controlling influence on the annual weather pattern in the islands.

Broadly speaking, the warm and equable Hawaiian climate is characterized by a "two-season" year; November through April is wetter and slightly cooler than the period May through October. There is relatively minor seasonal variation in temperature, and the daily range is also small except at high elevations in the mountains. At Honolulu, for example, the warmest month is usually August with an average temperature of 78.5° F; the coolest is January or February with a 72° F. average.

In contrast to the fairly uniform annual temperature pattern, Hawaiian rainfall shows considerable seasonal fluctuation from place to place and striking local variations due to elevation, slope exposure, and related locational factors. The marked differences in rainfall distribution result from the orographic influence of the various mountain masses on the prevailing winds. Annual rainfall averages only 20 inches or less on some leeward areas and exceeds 250 inches on some windward slopes and mountain summits. Rainfall intensities are also occasionally very high, the maximum recorded rate for one hour being 6.5 inches.

Three classes of widespread weather disturbances produce major storms: low pressure troughs, cold fronts, and hurricanes. The low pressure passages are known locally as "kona" storms because they ordinarily bring winds predominantly from southern quadrants. Cold fronts, on the other hand, bring strong northerly winds. Both types of storms cause heavy to torrential rain and high winds, but the rainfall in a well developed "kona" storm is more widespread and of longer duration than precipitation from the usual cold front storm. The winds of a "kona" storm are also generally steadier and more prolonged but usually not as intense as the more extreme winds of the cold front. Severe cold front storms occur on the average of once every 3 or 4 years.

Major storms may yield very high winds from any direction, although in most localities often the strongest winds are from the northwest and north. Extreme windspeeds resulting from these storms occasionally exceed 60 m.p.h. and may reach 100 m.p.h. momentarily, in gusts. It is not unusual to have maximum speeds of only 35 m.p.h. in one locality and speeds of 70 m.p.h. or higher in a restricted area only a few miles away.

Hurricanes also affect the Hawaiian area, but only four have been recorded in the islands since Weather Bureau observations first

began in 1904. These hurricanes all occurred during the past 15 years, in August 1950, September 1957, December 1957, and August 1959. The island of Kauai is the only main island of the Hawaiian chain ever struck by a hurricane. This phenomenon occurred in 1959.

g. Tides. Normal tidal fluctuations along the coasts of the main Hawaiian Islands generally do not exceed 2 feet in the range between lower low water and higher high water. There is relatively little difference in tidal range between the several islands and from place to place along the shore of the same island. The mean range averages around 1.5 feet. Extreme high tides do not exceed approximately 4 feet above mean lower low water datum.

h. Tsunami. Hawaii is subject to tsunami generated almost anywhere in the circum-Pacific seismic zones. Forty-one damaging tsunami have been recorded since 1819. Nine of these have been classified as severe or very severe on the basis of damages inflicted. The two most recent in the very severe class dealt heavy blows to the city of Hilo in 1946 and 1960 and caused lesser damage in other areas. A 1959 tsunami, classified as severe, caused considerable damages to property along the north coast of Kauai. Tsunami pose a potential threat to harbor facilities and small craft throughout the state. Unprotected small boat harbors and anchorages, where the waves can sweep into confined areas such as stream estuaries, are particularly vulnerable.

6. BOATING ACTIVITY AND THE EXISTING SMALL-CRAFT FLEET

a. General situation. Hawaii's social and geographic makeup and nearly ideal climate are such that many of her people are strongly attracted to boating, fishing, and water sports for both recreation and livelihood. Although boating is a popular avocation of an estimated 15,000 or more people in the islands and is directly connected with the occupations of some 2,000 or 3,000 others, boating is comparatively much less developed in Hawaii, however, than in many states on the mainland. Data for 1959 show that in the mainland United States as a whole there were 44.0 recreational boats for each 1,000 population, whereas Hawaii in 1961 had only 8.4 boats per 1,000. Even if Hawaii's temporary military population of about 53,000 is excluded and only the permanent civilian residents are considered, the ratio is only 9.1 boats per 1,000.

The lag in boat ownership in Hawaii as compared with the average trend on the mainland can be primarily attributed in large measure to the inability of the existing small-craft facilities in the State to meet actual demand for berthing space. The heavy annual damages to boats sustained in recent years because of insufficient protection from storm waves discourage many prospective boat buyers from actually purchasing new boats as does the lack of convenient or obtainable safe berthing space. These factors account in part for the increased popularity of trailer-mounted boats which now comprise approximately 40 percent of all small craft in the State. Interest in boating is clearly developed and growing and the desire for greater ownership and participation on the

part of the public is real, but Hawaii will continue to lag behind the mainland pace in boating activity until more and better facilities are provided the public.

With nearly 80 percent of Hawaii's population, Oahu is the home base of the majority of the small craft in the State, accounting for 70 percent of the total number of light-draft vessels of all types. The remaining 30 percent are distributed among the neighbor islands roughly in proportion to their population. It is noteworthy, however, that the ratio of the number of craft to population is larger for the least populated islands, indicating a significantly higher proportionate level of boating activity at the smaller coastal communities and in the predominately rural areas as compared with the metropolitan center of Honolulu and its environs on Oahu. Lanai, for example, with only 0.3 percent of the State's population has 30 recreational boats per 1,000 residents. The lower proportion of boat ownership among the urban residents of Oahu undoubtedly reflects the shortage of adequate berthing space at points convenient to the metropolitan area; however, the greater diversification of recreational opportunity as compared with rural communities is another influencing factor. The distribution of all small craft by island is shown in table 6, which compares the total number of boats and the population of each island.

Table 6

Boat Distribution and Population by Island

Island	Population	Boat count (Total, all types)
Kauai	27,922	473
Oahu	500,409	4,133
Molokai	5,023	146
Lanai	2,115	61
Maui	35,717	369
Hawaii	61,332	753
State totals	632,509	5,935

The broad classes or types of light-draft craft operating in Hawaii vary widely from expensive sailing yachts, cruisers, fishing, scientific, and work vessels to relatively inexpensive commercially-manufactured outboards and sailboats, homemade skiffs, and outrigger canoes. In 1961 the approximate numbers of craft by general categories, including all sizes, for the State as a whole were as follows: outboards, 4,636; sailboats, 392; cruisers, 330; sampans, 269; inboards, 175; and sailboats or sailing yachts with auxiliary power, 133. All of the approximately 6,000 boats in Hawaii can be grouped for convenience into the four functional categories of recreational, commercial fishing, charter, and work boats, which are discussed in the following paragraphs.

b. Recreational boating. Pleasure boating for recreation constitutes by far the predominate usage of small craft in Hawaii and accounts for 89 percent of all boats in the State. This type of boating ranges from interisland and long-distance cruising (and participation by a few local yachts in the famous biennial transpacific race between California and Hawaii) to inshore sailing, motorboating, and fishing. The great majority of the recreational boats are under 18 feet in length and their safe navigational capabilities restrict them to the latter type of activity. The rough waters in the interisland channels which prevail much of the time, the potential danger from storms and squalls, and the long distances between islands (with the exception of the Molokai-Lanai-Maui triangle) generally prohibit interisland cruising to all craft except the very largest inboards, the auxiliary sailboats, and the cruisers and sampans - most of which are 20 footers or larger. Figures 1 and 2 show representative sports cruisers and sailboats based at the State's Ala Wai Boat Harbor in Honolulu. The distribution of recreational craft by island and type and the ratio of boat ownership to population are shown in table 7.

Table 7

Distribution of Recreational Craft in the State of Hawaii by Island and by Type of Craft

Island	Moored outboards	Trailer outboards	Sail w/o power	Auxiliary sail	Inboards	Cruisers	Sampans	Total	Number of boats per 1000 population
Kauai	146	270	-	3	-	2	4	425	15.2
Oahu	1,362	1,533	383	125	115	241	31	3,790	7.6
Molokai	68	20	1	-	1	3	-	93	18.6
Lanai	39	16	-	-	1	-	4	60	30.0
Maui	82	224	2	2	1	16	21	348	9.6
Hawaii	235	311	3	1	2	21	9	582	9.6
State	1,932	2,374	389	131	120	283	69	5,298	8.4

Although there is a sprinkling of recreational boats based at harbor sites, anchorages, and beach areas along the coasts of all the islands outside of the cliffed zones or other inaccessible reaches, the bulk of the pleasure craft are operated in the relatively sheltered waters off the leeward shores of the main islands. Windward areas where notable exceptions occur are Kaneohe Bay and Kailua Bay on Oahu and Hilo Bay on Hawaii. The two bays on Oahu are shielded from heavy seas by an offshore barrier reef, while a large part of Hilo Bay is protected by the Federal breakwater of the Hilo Harbor project.

Trailer-mounted outboards comprise 45 percent of the 5,298 recreational craft in the State. The majority are in the 14- to 18-foot size range. The growing popularity of trailer-mounted boats in

recent years stems from a number of factors including the increased availability in the islands of newer models manufactured on the mainland and their relative economy and overland mobility. Sample interviews with trailer-mounted boat owners do reveal, however, that many would prefer to moor their boats at a harbor near their place of residence if convenient and safe berthing space were available.

The rapid growth rate of recreational boating seen on the mainland in the past two decades is now beginning to be experienced in Hawaii. Continued growth would appear to be dependent upon the provision of extensive harbor improvements.

c. Commercial fishing.

(1) Scale of industry and fish catch. Commercial fishing is of local economic importance in Hawaii as a source of income and food, but as an export industry to out-of-state markets it is small and not comparable in size to the major mainland fisheries. The only fish cannery in the State is located at Kewalo Basin, Honolulu. Fishing is carried on throughout the year in Hawaiian waters; however the bulk of the skipjack or tuna catch is made during the spring and summer season from April through August. Skipjack operations comprise the most significant and specialized facet of the Hawaiian fishing industry, accounting for about 80 percent of the total commercial fish catch. Skipjack, generally called tuna and known in Hawaii as aku, is a popular food fish in the islands.

The tuna fishery in Hawaii has declined in recent years partly because of loss of experienced fishermen to shoreside employment. Decline of the tuna fishery is also attributed to a scarcity of bait fish. A drop in the number of large tuna boats in operation has resulted. The State of Hawaii, with the cooperation of the U. S. Bureau of Commercial Fisheries, is attempting to revitalize the tuna industry by artificial propagation of bait fish and application of new fishing techniques.

The total recorded commercial fish catch in Hawaii in 1960 was over 11 million pounds valued at $2.7 million. That year tuna accounted for some 9 million pounds of the catch and was valued at $1.7 million. This is a considerable drop from the postwar peak in 1954 of 17.3 million pounds of tuna.

Ocean fishing both from shore and boat is an extremely popular pastime in Hawaii and the recreational catch, although of minor proportions compared with the commercial catch, is substantial. There is no reliable record or estimate of the part-time commercial catch taken by persons, particularly in the rural areas, who supplement their income by occasional fishing over and beyond recreational fishing for pleasure or for their own use.

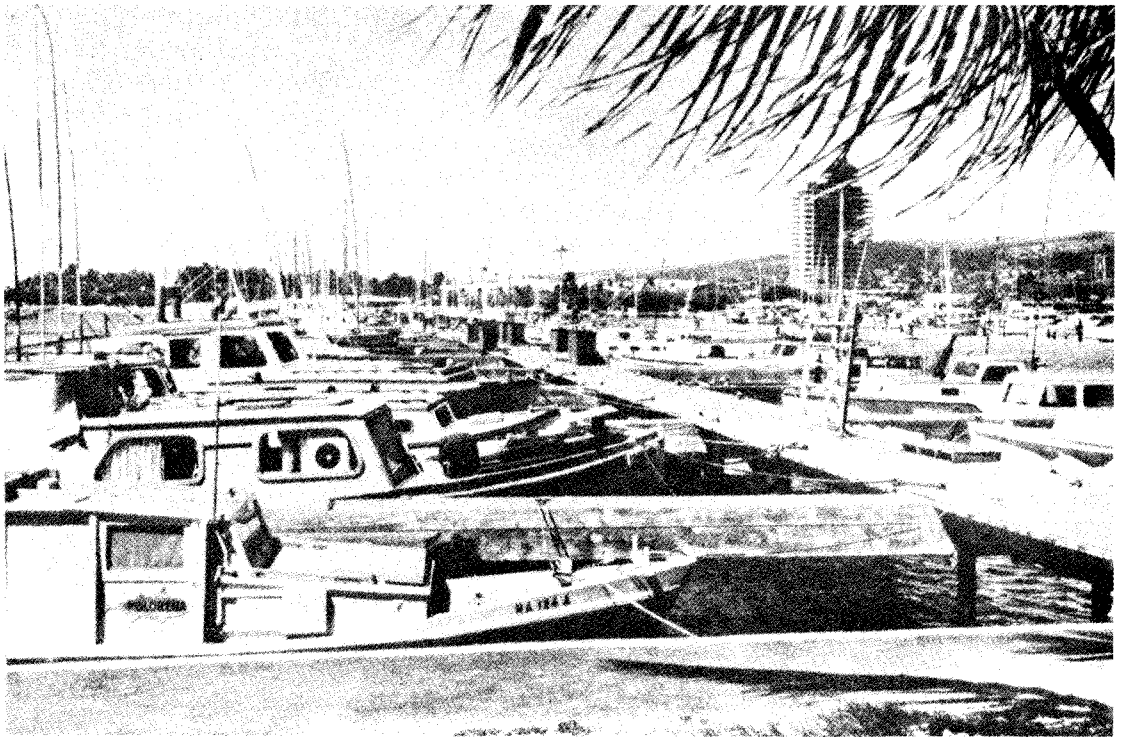


Figure 1. View of recreational craft in Ala Wai Boat Harbor, Honolulu, showing full utilization of berthing facilities. 1961.

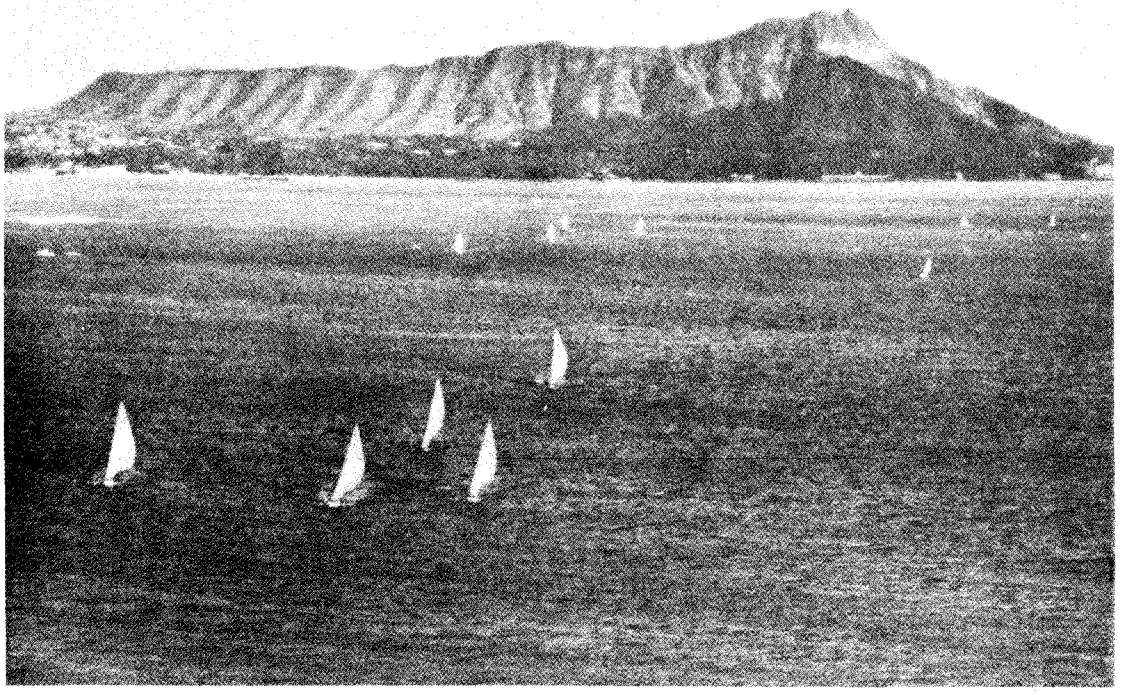


Figure 2. Sailboat racing off Waikiki. 1961.

(2) Fishing boats and type of operations. The 1961 boat inventory by the State identified 529 commercial fishing craft distributed among the six major islands. This is 9 percent of all small craft in the State. The principal fishing fleets are based on Oahu and Hawaii; smaller concentrations of boats are located on Molokai and Kauai. A few inboard boats and cruisers are used by commercial fishermen, but the fleets consist essentially of sampans and outboards. The sampan is a rugged craft of wood construction adopted from Japan. The larger sampans are particularly well suited to extended deep-sea operations, whereas the outboards of various types are relatively restricted in range to inshore waters or runs of less than 15 miles. The outboards are also generally limited to operational periods of one day or less. While the outboard fleet is largest in number (see table 7), its total fish catch is small relative to that taken by the sampan fleet.

The usual range of operations varies depending upon the location of the home port or launching site with respect to the location of the fishing grounds and upon cruising limitations imposed by size of craft. For example, the average one-way normal run of sampans operating out of Honolulu Harbor and Kewalo Basin on Oahu is nearly 100 miles whereas the sampans at Port Allen, Kauai, ordinarily go out only about 11 miles. From Hawaii and Maui the normal sampan runs average near 20 miles. In contrast, outboard fishing boats average runs of only slightly over 6 miles to the fishing grounds. Figure 3 and figure 4 show typical sampans commonly used by professional fishermen in Hawaiian waters. Table 8 presents the numerical distribution by county of the two general classes of fishing craft discussed above.

Table 8

1961 Distribution of Commercial Fishing Boats by Island

	Kauai	Oahu	Lanai	Molokai	Maui	Hawaii	State total by type
Sampans and cruisers over 25 feet long	22	105	1	1	3	45	177
Outboards and inboards under 25 feet[1/]	9	171	0	50	15	107	352
Total of all types	31	276	1	51	18	152	529

1/ Includes a few small sampans.

(3) Future growth of fishing industry. Should present efforts to stimulate the fishing industry to greater production prove fruitful, a modest increase in the number of specialized fishing sampans is foreseeable in future years. However, prospects of major growth beyond

previous high levels do not appear bright, although there will probably be a considerable increase in the number of outboard fishing boats used on a part-time basis as the population in the islands expands.

d. Other commercial boats. Deep-sea fishing for marlin and other game fish in Hawaiian waters has long been world renowned among sportsmen. The sport has also become an increasingly popular aspect of the general resort industry in recent years. Most of the charter boats for sport fishing or pleasure cruises are concentrated at Honolulu and at Kailua-Kona on the island of Hawaii. The majority of the commercial sightseeing craft in the islands are located at the Kewalo Basin at Honolulu except for a small concentration of inboards which operate on the Wailua River, Kauai. There were 83 charter and sightseeing boats counted in the 1961 boat census - 12 on Kauai, 54 on Oahu, 2 on Maui, and 15 on Hawaii. In addition, 25 miscellaneous work boats were identified, bringing the total of commercial craft other than fishing vessels to 108. Although charter boat operations are highly competitive, the expanding tourist industry will provide impetus for growth in this facet of small craft activity in the State during the coming years. A representative cruiser used for charter boat fishing is illustrated in figure 5.

7. EXISTING HARBORS FOR LIGHT-DRAFT VESSELS

a. Distribution and adequacy. Hawaii has very few good natural harbors or anchorages that afford vessels adequate protection from storms or from the rough seas generated by prevailing winds. Pearl Harbor on Oahu, the largest and best natural harbor in the islands, is reserved for the exclusive use of the U. S. Navy and is therefore closed to civilian boating. Because of the paucity of good sites, nearly all of the existing improved harbors in the State (both deep and light draft) have required the construction of extensive protective works to augment the limited natural protective features of the site to the best advantage. Of 66 harbors and anchorages scattered along the nearly 1,000 miles of coastline of the 6 main islands which were used regularly by small craft at the time of the 1961 boat inventory, two-thirds were strictly fair weather ports. Docking, mooring, launching, and service facilities were satisfactory at only a few of the harbors. The Ala Wai Boat Harbor in Honolulu, although crowded, is the only first-rate large harbor facility in the State for recreational craft. The Kewalo Basin for light-draft commercial vessels, also in Honolulu, likewise is the only fully satisfactory installation of its type.

The existing improved harbors are not equitably distributed throughout the State in terms of local small craft needs, although steps are currently being taken by State agencies in their planning and construction programs to improve this situation. Nonetheless, several long coastal sectors, some with considerable population, are and will continue to be entirely lacking in small craft facilities. From the standpoint of

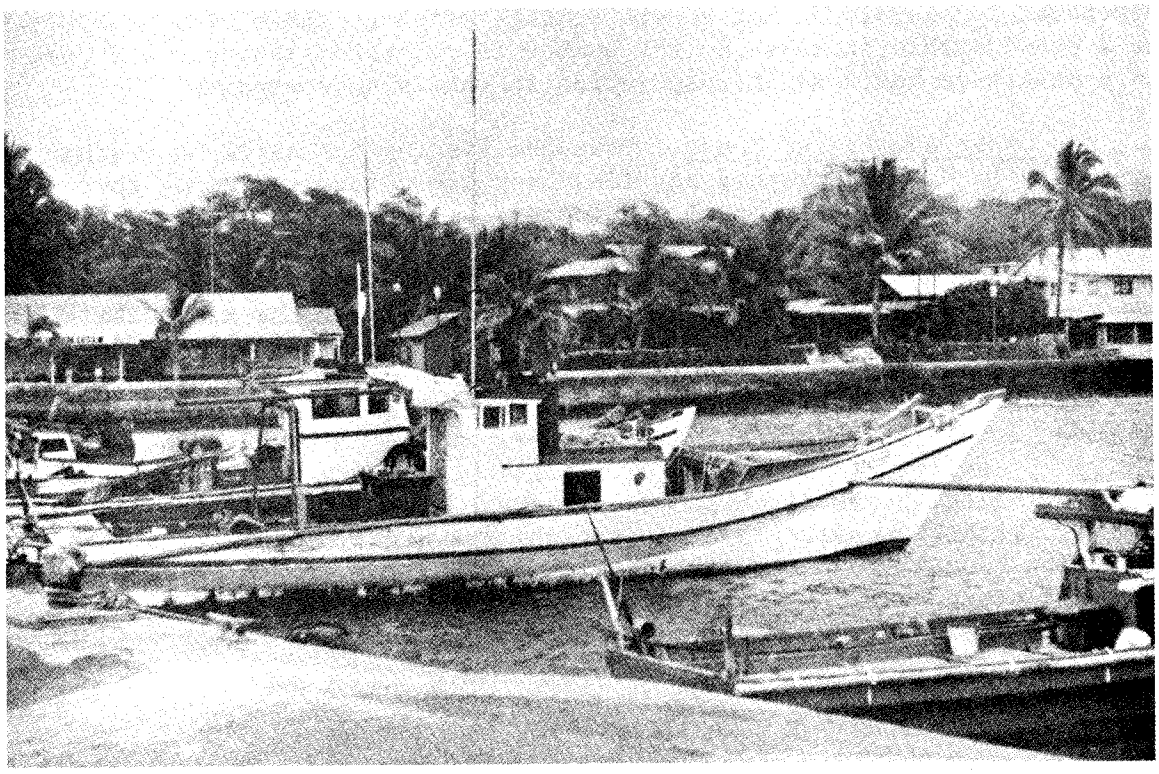


Figure 3. Fishing sampans at Kailua Kona, Hawaii. 1960.

Figure 4. Commercial sampans at Wailoa River fishing terminal, Hilo, Hawaii. 1960.

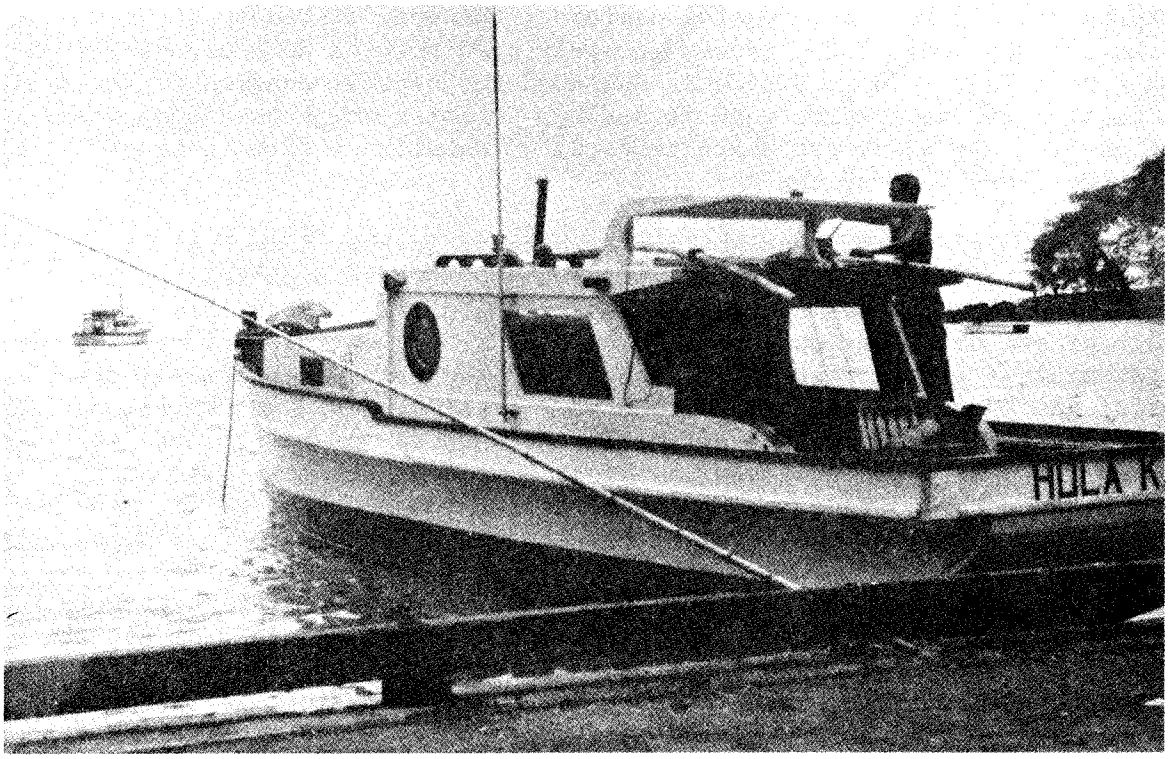


Figure 5. Sports-fishing charter boats at Keauhou Bay, Kona, Hawaii. 1960.

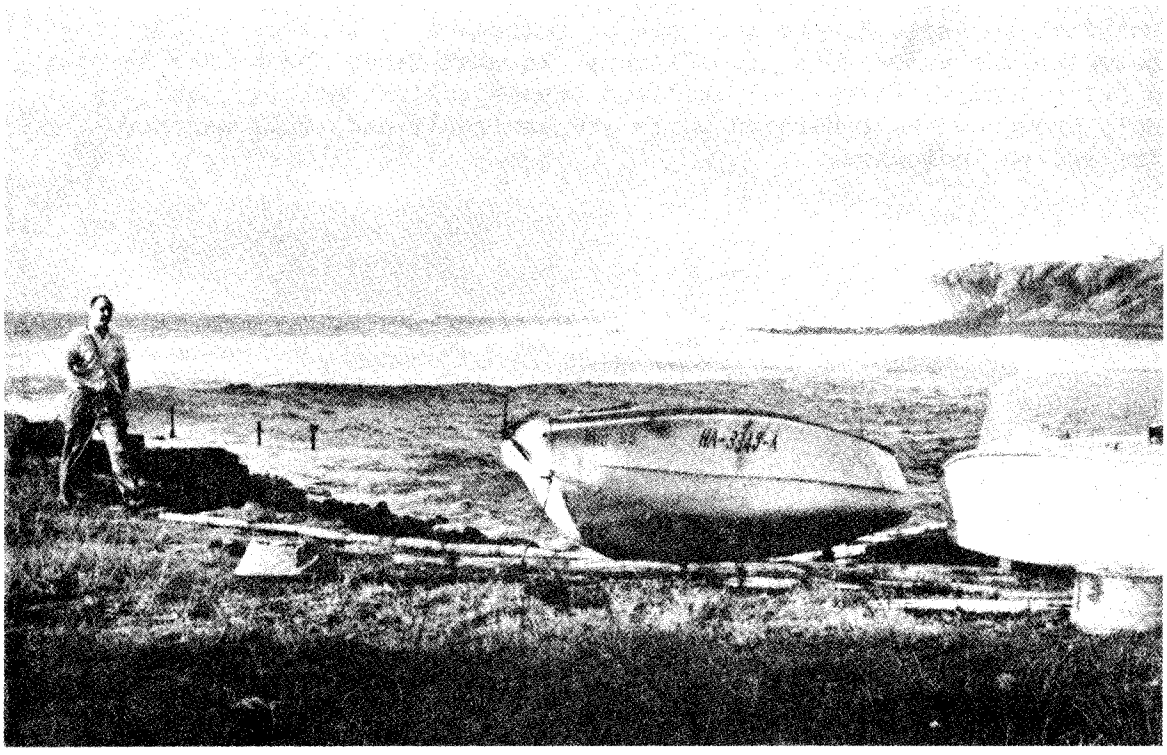


Figure 6. Representative craft of the more than 1,400 boats located at unprotected coastal sites in Hawaii outside of harbors. 1960.

interisland movement and coastal cruising, the long distances between safe harbors along some of the routes commonly used present an added hazard in boat operations. These distances compound the natural dangers involved in light-draft navigation such as strong currents, rough or choppy seas, and gusty winds which are characteristic of Hawaiian waters in many offshore areas much of the time.

Most of the present small-boat harbors in Hawaii were built by the former Territorial Government under the direction of the Territorial Board of Harbor Commissioners. Since Statehood, six harbors have been built or are now under construction by the Harbors Division of the State's Department of Transportation. Through 1962 the State and former Territorial government expended more than $3.7 million on the construction, improvement, and maintenance of small-boat harbors and harbor facilities. Plates 2 - 6 show the geographical distribution of the most frequently used boat harbors, landings, and anchorages throughout the State. The same plates summarize the level of development at each harbor or site.

b. Existing harbors. Twenty-two of the principal existing harbors in the State are identified by island in table 9 which also presents the approximate number of based craft at each harbor in 1961 and the estimated boat capacity based on established installations as of January 1963. Five of the harbors listed were improved by the State in 1962. These are Kikiaola and Port Allen, Kauai; Heeia-Kea and Keehi, Oahu; and Manele Bay, Lanai. Another, Ala Wai on Oahu, the State's best boat harbor, will be under expansion in 1963. Only a few of the harbors identified in table 9 have adequate or reasonably satisfactory berthing accommodations and service facilities. In most cases the better harbors are being fully utilized, or utilized beyond design capacity, and are unduly crowded. Four harbors which are basically only fair weather ports are so indicated.

Table 9

Principal Harbors for Small Craft in Hawaii, 1962

Island	Harbor	Approximate number of based craft (1961 inventory)	Approximate capacity of berthing and mooring facilities 1963
Kauai	Kikiaola (S)	3	20
	Port Allen (S)	31	60
	Nawiliwili	20	51
Oahu	Ala Wai (Honolulu)(S)	526	668
	Hawaii Kai (P)	-	20 2/
	Heeia-Kea (S)	69	135
	Honolulu Harbor (S)	23	12
	Kaneohe Anchorage (P)	53	41
	Kaneohe Yacht Club (P)	144	62
	Kewalo Basin (Honolulu)(S)	122	90
	Keehi (Honolulu)(S)	314	450
	Pacific Yacht Club (M)(Honolulu)	57	21
	Iroquois Point (M)(Pearl Harbor)	20	30
	Pokai Bay (S)	66	76
	Haleiwa Harbor (P)	56	56
Molokai	None		
Lanai	Kaumalapau 1/ (P)	24	26
	Manele Bay 1/ (S)	-	40
Maui	Lahaina (S)	26	31
	Maalaea (S)	34	62
Hawaii	Kailua-Kona 1/ (S)	29	49
	Kawaihae (S)	27	27
	Keauhou Bay 1/ (S)	24	61
	Wailoa River (Hilo)(S)	52	75

1/ Fair weather port only.
2/ Approximate number of based craft January 1963. Marina under development.

(S) State-owned facility.
(P) Private facility.
(M) Military facility.

c. Unimproved sites. There are about 40 unimproved harbor sites and anchorages along the coastlines of the major islands which are utilized by local boats and occasional transient craft. These sites include natural stream estuaries, the lower canalized reaches of streams in some urban areas, small bays or coves, inlets or natural openings in reef areas, and relatively sheltered beach zones where boats are beached or moored in shallow water. They are used to varying degrees; some seldom, others frequently. A few accommodate a significant number of regularly based craft. Nearly all of these sites, however, become untenable or dangerous for boats when storm waves strike from their exposed sides, although they may provide good to fair shelter during storms from other directions. An exception is the stream estuaries which generally afford a good haven from storm waves, but, on the other hand, are vulnerable to flooding and tsunami.

8. DIFFICULTIES ATTENDING NAVIGATION

General hazards to navigation peculiar to Hawaiian inshore waters make boating potentially dangerous in many areas to both the novice operator and the experienced sailor unfamiliar with local conditions. These hazards include the many lava reefs and rocky shoreline features which are exposed to heavy wave action characteristic of the cliffed or higher coastal sectors of each island. Equally as dangerous, if not more so, are the coral reef formations which occur as both fringing and offshore barrier reefs; some of the low-lying coastal sectors have both types. Isolated coral heads are common between the two types of reefs and occur in and around all of the more massive coral formations. The coral poses a constant threat of grounding, particularly at low tide, should the navigator stray from established natural or man-made channels. There is also a continuous danger of being driven aground on the outer face of the reefs by wave action, especially when high seas or swells are running. The prevailing trade winds, frequently strong and gusty, compound these dangers on the windward coasts. Full-scale storms are uncommon during the year, but local squalls are often generated by convection or minor pressure disturbances. Added to these natural hazards are the difficulties to boat operators and dangers to craft resulting from the inadequate protection and facilities afforded by many of the existing boat harbors and anchorages. Specific hazards to navigation are noted in conjunction with the discussions in section 16 of the individual harbor projects proposed for Federal participation.

9. HARBOR SPACE REQUIREMENTS FOR SMALL CRAFT

a. Immediate requirements. Statistics of the boat inventory and harbor capacity studies reveal a pressing need for more protected harbor space for light-draft craft at most of the boating centers and populated coastal areas throughout the islands. The 1961 boat census was a carefully conducted physical count of all classes and types of light-draft craft in both the commercial and recreational categories. This count can

be considered accurate within a small margin of error, although it is undoubtedly a conservative tabulation since operating boats absent from their accustomed bases at the time of the inventory were not included. Nor does it account for a significant number of craft added to the boat population since June of 1961. However, the inventory was conducted at harbors generally at times of day when the minimum number of craft would customarily be at sea.

Of a total of 5,935 boats identified throughout the State in the 1961 inventory, only 2,135 or 36 percent were based at harbors. Nonwater-based trailer-mounted boats accounted for 2,374 craft, and the remainder of the boats in the total count consisted of 1,426 craft located on beaches or moored along the shore at locations outside of harbors. Figure 6 shows typical craft in this latter category. Eliminating the trailer-mounted boats and considering only those water-based or beach-based craft, the immediate total requirement facing the State for protected harbor space for existing craft can be established as being approximately the combined total of these two categories, or 3,561 harbor spaces. At the time of the boat inventory in 1961 only about 40 percent of this immediate demand for protected space was being satisfied by the improved harbor facilities in the State. With subsequent completion of new improvements by the State, as of January 1963 nearly 50 percent of the existing demand for berthing space for water-based craft could be considered adequately satisfied. However, of the total of more than 2,100 harbor-based craft, only about 1,800 could be considered as safely based in January 1963 in spite of the recent improvements by the State. As far as the undeveloped harbors and anchorages throughout the State were concerned, only about 190 of the more than 400 boats based at such unimproved sites were located at reasonably safe sites. In addition, a large number of the many trailer boat owners would prefer to keep their boats in the water at a harbor convenient to their homes if satisfactory berthing or mooring space were available. Table 10 shows immediate space requirements by islands.

b. Future requirements. Hawaii's population showed a 26 percent increase during the decade 1950-60, and the expansion of the local economy was generally impressive. However, the growth in the population and economy was concentrated almost entirely on the island of Oahu. In fact, all of the islands except Oahu lost population. Oahu's present potential for continued growth is good, and prospects for expansion of the economies of the other islands are improving somewhat, mainly in the tourist industry. The State as a whole is now beginning to experience the rapid growth in recreational boating activity already displayed on the mainland in recent years. Considering the State's overall growth potential, the clearly expanding interest in boating, and the favorable year-round climate, the demand for light-draft harbor space can be expected to increase to a marked degree in coming years. Projections of the anticipated demand for harbor space in the years 1965, 1980, and 2010 are given in table 10. The State's population and personal income projections constitute the two principal factors upon

36-957 O-64—4

which projections of the State's future boat population and resulting harbor space requirements are based. These basic projections are contained in appendix C.

Table 10

Projected Harbor Space Requirements for Light-Draft Vessels in Hawaii by Island[1/]

Island	1965	1980	2010
Kauai	280	420	700
Oahu	2,970	6,140	9,660
Molokai	180	250	370
Lanai	90	120	190
Maui	190	320	540
Hawaii	580	900	1,390
State total	4,290	8,150	12,850

1/ Excludes present craft adequately accommodated.

10. IMPROVEMENTS DESIRED

Following initial Congressional authorization of a preliminary examination and survey of the coasts of the Hawaiian Islands for harbors for light-draft vessels in 1950, six public hearings were held to obtain testimony on local views relative to the needs for small-boat harbors throughout the Territory. These hearings were held at Hilo and Kailua on the island of Hawaii, Wailuku on Maui, Kaunakakai on Molokai, Honolulu on Oahu, and at Lihue on Kauai. Completion of the survey was deferred because of lack of funds. Upon reactivation of the coasts of the Hawaiian Islands survey, hearings were held again at the same six places in January 1959 to gather current information and public opinion.

These public hearings were attended by representatives of Federal, State, county, and municipal agencies, civic and boating organizations, and by interested private individuals. The local interests testified that there was, and had been for many years, an acute shortage of small-boat harbors and related boating facilities in Hawaii. They stated that the lack of adequate protected harbor space and other shore-side improvements had impeded the growth of recreational boating and of the boating industry in general as well as having worked a hardship on many people who depend on boating in one form or another for their livelihood. A stepped-up program for the improvement and development of harbors for light-draft vessels was strongly advocated. The testifiers pointed out the urgency of the situation in view of the heavy damages sustained by small craft in the past, the continuing threat to life and property, and the predominant and increasing inadequacy of

existing facilities to protect and accommodate the rapidly-growing numbers of boats at the majority of boating centers throughout the islands. It was stressed that many people in Hawaii earn their living by commercial fishing and charter-boat operations and that many more supplement their income or food supply by part-time fishing. It was also emphasized that sport fishing and boating are major recreational pursuits of the people of the islands and that boats and associated gear represent a very large capital investment on the part of the public.

During the course of the 12 hearings held, various local interests recommended or suggested approximately 40 sites for study for potential light-draft harbor projects. This list of sites included most of the existing improved and partially improved harbors, which were requested to be studied for further expansion, as well as all of the commonly-used natural harbors and anchorages which were still unimproved or very little improved. Also suggested were a number of natural sites in comparatively remote little-used areas which could serve as possible refuge havens. Subsequently, as a result of discussions with State authorities, the final number of sites requested for consideration was raised to 45. All of these sites have been investigated in this survey along with a number of others.

The Committee on Public Works, House of Representatives, 85th Congress, 1st session, held hearings on public works projects for Hawaii in November 1957. At these hearings local interests requested that the studies in connection with this survey include harbors at the closer points of each of the main islands for possible use in a future roll-on roll-off ferry system in addition to the harbors for small-craft use and refuge.

At the public hearings detailed proposals for small-boat harbors were made in connection with only one of the suggested sites. Where a local site was favored, the testimony given was largely of a general nature, emphasizing the pressing local need and the scale of the requirements rather than citing some specific plan of improvement already conceived and favored by a significant number of the local residents and boat owners. The consensus generally was that improvements were badly needed, and it was implied or stated that the layout and structural details of the improvements were matters to be left to the technical discretion of the Corps of Engineers and the State Harbors Division. The principal exception to this trend of the testimony was in regard to an urgently-needed small-craft facility at Kailua Bay, Oahu, where a number of local interests favored a specific plan. This proposed plan consisted basically of the construction of a 1,150-foot causeway from Alala Point (between the communities of Kailua and Lanikai) to a small, low-lying coral island (Popoia Island). It was stated that a safe mooring area for a large number of boats would thus be created in the lee of the causeway and island and that a new recreation beach would accrete between the shore and the island

along the outer side of the causeway or breakwater. Access to the island, an undeveloped State property, and to boat moorings would be possible along the top of the causeway, the shore end of which would be on public land now part of a municipally-owned beach park.

11. NEED FOR A HARBOR SYSTEM PLAN

The formulation of a basic Statewide plan for harbor development was considered necessary to relate the roles individual local projects would play in contributing towards the fulfillment of the State's total light-draft navigation needs. Although the State had derived a partial plan for boat harbor development in connection with its capital improvement program, no comprehensive plan was available. At early coordination meetings with local interests, a planning framework was evolved to approach this survey in a manner that would identify overall needs throughout the islands and result in the selection of a system of potential projects that would best satisfy the basic general needs of the entire State. With the formulation of this plan, forthcoming Federal contributions in the form of authorized projects could thus be geared effectively with the State's own independent harbor development program. All future projects would then fit into a coordinated system aimed at accomplishing the most good at the least cost. The State's present harbor development plans could then be adjusted to Federal proposals as necessary by financing some needed projects in other localities where Federal improvements could not be justified economically.

12. PROPOSED BASIC SYSTEM OF BOAT HARBORS FOR THE STATE OF HAWAII

The first step in establishing a planning framework for the systematic and integrated development of all future light-draft navigation projects for Hawaii was to select a basic Statewide system of harbor projects considered to be most urgently needed at the present time to satisfy the bulk of the immediate demand for harbor space facing the State. The second step was to include allowances in the plan for anticipated growth of the State's boat population so that both short-range and longer-range requirements for harbor space would be taken into account in project selection and formulation. Nineteen harbor projects were found to be essential if the major part of the present pressing demand for safe harbor space is to be satisfied in the near future. In 1961, this demand was approximately 1,900 spaces for existing water-based craft alone, not to mention an undetermined number of trailer-mounted craft whose owners would prefer to keep their boats in a safe harbor. As noted previously in this report, it is anticipated that this demand for harbor space will increase to over 4,000 boats by 1965 and to approximately 8,000 boats by 1980. The 19 projects, considered as priority requirements in the State's harbor development program, include expansion and further improvement of 7 existing harbors and new harbor construction at 12 unimproved sites. They were chosen after study and screening of more than 45 harbor sites. The primary factors taken into account and weighed carefully in comparing the many possible sites during the process of selecting

the system of urgently-needed projects were (1) the relative degree of local need based on the existing unsatisfied demand of safe harbor space in the site's tributary area, (2) anticipated future space requirements based on the projected boat population of the tributary area, (3) the desires of local interests, (4) current use of the site, (5) accessibility of the site and its physical suitability in terms of design aspects and engineering feasibility, and (6) cost and benefit relationships. Another consideration of importance was the locational pattern of projects in relation to the State's area, coastal geography, and population distribution. Selection was made with a view to providing as strategic and equitable a distribution of projects as practicable among the six main islands of the State. Enhancement of boating opportunity to the greatest degree possible for the majority of the public was also a fundamental objective in determining the initial planning system.

The 19 harbor projects selected to constitute the proposed basic harbor system for the State would have a total design capacity of approximately 7,000 boat spaces for based and transient craft. These projects would augment and expand on the existing light-draft improvements in Hawaii to the degree necessary to bring the State's boating facilities up to a level of sufficiency where they can accommodate the bulk of the public requirements for harbor space in most significant population areas through the year 1975. It is proposed that 6 of the 19 projects would be entirely State financed since 3 were constructed by the State in 1962[1/] and 3 others are already being actively planned by the State[2/]. Of the remaining 13 projects in the proposed system, 4 are currently being studied by the Honolulu District under the program for small navigation projects authorized by section 107 of Public Law 86-645[3/]; a light-draft project at Kaunakakai, Molokai, as described in House Document 484, 87th Congress, has already been authorized; and the 8 other projects are recommended in this report. The distribution pattern of the proposed basic system of urgently-needed harbors and the identification of the projects is shown on plate 1, which also indicates the types of projects and those constructed in 1962 or under improvement in 1963. It should be noted that the initial portion of the harbor at Manele Bay on Lanai, one of the four proposed "107" projects, was constructed in 1962 by the State in advance of Federal authorization. However, the first increment at Manele cannot be considered an adequate completed project because of lack of breakwater protection and a satisfactory entrance channel.

1/ Kikiaola and Port Allen boat harbors on Kauai; Keehi marina at Honolulu, Oahu.

2/ Ala Wai Boat Harbor at Honolulu, Oahu; Wailoa River (Hilo); and a marina for the Kona District, island of Hawaii.

3/ Manele Bay, Lanai; Haleiwa, Oahu; Nawiliwili, Kauai; Maalaea, Maui.

13. BASIS OF DESIGN

a. General. The general plans of eight light-draft projects proposed in this report for Federal construction are described individually in subsequent paragraphs and shown on plates 7, 8, and 9. The order of presentation reflects the geographical distribution of the project sites, beginning with Hanalei Bay, Kauai, at the northwest end of the chain of the major Hawaiian Islands and concluding with Reeds Bay (Hilo) on the southeastern island of Hawaii. Portrayal of any self-liquidating improvements on the plans which are additional to features proposed for Federal construction is only intended to represent one feasible design possibility. Dredged material would be used in the construction of the moles and landside fill areas at most of the projects. The objective of each plan is to provide each boat harbor with the following basic features or to allow for the development thereof: (1) a safe entrance channel of suitable dimensions and depth to satisfactorily accommodate the present and future vessel traffic; (2) adequate interior access channels leading to landing and service facilities; (3) berthing or mooring areas of suitable size to meet projected space requirements; (4) an adequate public landing or service frontage with appropriate space for all necessary service facilities; and (5) a convenient and safe launching ramp or ramps as required, sufficient parking space, suitable access roadways, and satisfactory public comfort facilities. All eight sites of the proposed projects are readily accessible by State highway, county road, or the streets of the local community concerned. Short access roadways for construction purposes and to the new parking areas, service frontage, and launching ramps would be built by the State in connection with providing the necessary land, easements, and shoreside facilities for each project. Figures 7 through 14 are aerial photographs of each proposed site with the generalized plan of the harbor layout superimposed for orientation purposes.

b. Design capacities. The design capacities of the eight harbors proposed for Federal construction are tabulated in table 11, which also indicates the projected demand for berthing or mooring space at each proposed harbor for selected years. The demand figures shown include future requirements in terms of average boat space for all categories of recreational and commercial fishing craft expected to use the facility. An allowance for transient craft is included, but the demand estimates exclude launched trailer-mounted boats expected to utilize the harbor ramps. Individual design capacities were selected to meet current requirements and allow for the expansion of the local boat populations over the next several decades to the year 2010. The total design capacity of the eight proposed projects described in subsequent paragraphs is for approximately 4,300 boats. This figure represents about 33 percent of the total 2010 requirement for the state as a whole and approximately 61 percent of the total design capacity of 7,000 spaces for the basic system of 19 urgently-needed harbors discussed in the preceding section of this report. The overall State requirement by the year 2010 is projected at over 13,000 spaces for all water-based light-draft craft.

Table 11

Design Capacities and Projected Demand for Harbor Space at Proposed Projects

Island	Name of harbor	Design capacity	Estimated future boat space requirements 1965	1980	2010
Kauai	Hanalei Bay	180	50	110	180
Oahu	Waianae	380	110	210	380
	Heeia-Kea	1,600	450	1,130	1,600
	Kailua	680	220	470	680
	Maunalua Bay	950	300	600	950
Maui	Lahaina	160	60	100	160
	Hana	70	25	45	70
Hawaii	Reeds Bay (Hilo)	270	80	150	270

Local interests have not proposed any specific plans for the non-Federal portions of the proposed projects. However, in all cases adequate harbor berthing area has been provided for in the general plans presented herein to meet projected capacity requirements to the year 2010. Table 12 lists the approximate size in acres of the berthing or mooring areas for each of the proposed projects, based on the year 2010 design capacity, and also gives the anticipated density of boats per acre at that time. Variance among harbors in the amount of berthing space allowed per boat reflects differences in the size and type of craft expected to use the facility. In the plan for the Maunalua Bay harbor, allowance is made for the construction of interior moles which could be used effectively in development of the berthing facilities. The high number of boats per acre at the Kailua project would result from harbor utilization by only motor boats or power craft under 20 feet in length as explained in section 14d.

Adaptability of the proposed moles and breakwaters at the 8 harbor projects to provide recreational fishing for the general public is not proposed for the following reasons: (1) At Hanalei Bay an existing pier adjacent to the proposed jetty extends into deeper water and affords a better vantage point for fishermen; (2) Waianae and Reeds Bay harbors would require capping of the breakwaters, which would impair their structural stability; (c) The interior areas at Heeia-Kea would be completely occupied by berthing facilities; however, portions of the proposed moles would provide good fishing vantage points on the seaward side. The moles would be protected by rubblemound revetment which would require a concrete cap to be used as a safe fishing platform. Such capping is not desirable from a stability viewpoint, and even if a concrete cap were provided, the fishermen would climb down the seaward slope to be nearer the waterline; (d) There would be little demand for recreational fishing at Kailua Harbor and the harbor plan is not readily adaptable for such provisions; (e) The depth of water in the vicinity of the proposed moles at Maunalua Bay is not sufficient to afford good fishing; (f) At Lahaina the breakwater would be detached and therefore not readily accessible to fishermen and the depth of water seaward of the breakwater is not sufficient to afford good fishing; (g) Fishing from the breakwater at Hana would be dangerous and would be discouraged.

Table 12

Berthing Space Allowances of Proposed Projects

Island	Name of harbor	Planned berthing area in acres	Number of boats per acre
Kauai	Hanalei Bay	5.5	33
Oahu	Waianae	10	38
	Heeia-Kea	40	40
	Kailua	11.5	59
	Maunalua Bay	44	22
Maui	Lahaina	5.3	30
	Hana	2.5	28
Hawaii	Reeds Bay	9	30

c. Depths and widths of entrance channels. The selected depths and widths of the entrance and other general navigation channels of the proposed projects were evaluated and determined on an individual basis with due consideration being given to the following factors as applicable to each harbor: (1) the beam, draft, and clearance requirements of the larger types of craft expected to use the facility, including allowance for transient traffic, and the total number of boats expected to be based at the harbor or operate in the channels; (2) wind, wave, and current conditions and their effect on the movement and control of craft; (3) local hydrography and the nature of bottom materials; (4) tidal ranges and estimated shoaling rates; (5) exposure of the site to deepwater waves; and (6) the views of experienced local boat operators and responsible State officials of the Harbors Division, Department of Transportation. Except at the Kailua project, as explained under the discussion of the proposed plan of improvement, the largest craft expected to use the planned harbors would have a draft of approximately 9 feet and a beam of about 18 feet. A number of craft of this size, ranging in overall length from 75 to 105 feet, are already operating in Hawaiian waters and more are anticipated in the future. Attention was given to determining the required thickness of a "water cushion" to allow a margin of safety under the keels of the deeper draft craft expected to use the channels. The effect of deepwater swells and wave action, particularly in the outer reaches of the entrance channels, was given careful study in this connection and as related to the control of craft navigating these critical areas. The relative cost of providing an extra margin of width or depth for safety reasons was weighed carefully in relation to the total investment anticipated in the proposed improvements as a whole. The depth and

width allowances made are considered fully in keeping with the practical requirements of the site and the expected usage of the project. In regard to item (1), a problem requiring special consideration is the emergency evacuation of boat harbors during tsunami warnings which occur from time to time. In the case of those coastal projects which would involve several hundred based craft, congestion of channels during a rapid evacuation would be critical and width allowances are made for such situations. The proposed project depths indicated in the plans of improvement for dredged channels and turning basins allow for 2 feet of overdepth, except at Heeia-Kea and Lahaina where 1 foot was used.

d. Design wave. The design wave heights for the protective structures at Waianae, Maunalua Bay, Lahaina, and Hana were determined to be governed by the depth of water at the toe of the protective structures. For the proposed harbor at Hanalei Bay, the design wave height was derived by wave refraction analysis whereas, for the planned structures at Heeia-Kea and Reeds Bay (Hilo), the design wave was established by analysis of the effective wind fetch. Based on an analysis of tidal forecasts and records for Honolulu Harbor, an astronomical tide of 2.5 feet above mean lower low water datum was selected and used in determining the stillwater surface for design wave height computations. This tidal level for Honolulu was adjusted to the particular location of each proposed project by applying an appropriate correction factor. An additional allowance of 0.5 feet was made for wind setup.

e. Armor units. The sizes of the individual armor units in the planned breakwaters, revetted moles, and groins were obtained from stability formula developed by the Corps of Engineers' Waterways Experiment Station (WES). The shape factors used are those recommended in the BEB Technical Report No. 4. Supporting data on design details and criteria are contained in appendix A.

14. PLANS OF IMPROVEMENT

a. Hanalei Harbor, Island of Kauai.

(1) Description. Hanalei Bay is located on the north coast of the island of Kauai about 35 road miles from Lihue, the county seat of Kauai County. The nearest light-draft harbor is 40 nautical miles away at Nawiliwili. The village of Hanalei at the head of the bay had a 1960 population of 370, while the Hanalei Judicial District, comprising the north coastal area of Kauai and the immediate tributary area of the proposed project, had a total population of 1,312 at that time. A major resort hotel was newly opened on the east side of the bay in 1961. The area is served by the Kauai Belt Highway which connects the major towns on the island. Hanalei Bay, semi-circular in shape, is situated between two headlands

and the entrance is about 1-1/4 mile wide. Depths in excess of 5 fathoms prevail at approximately 1,000 feet offshore. The Hanalei River, which has a tributary area of approximately 23 square miles, drains the valley inland from the bay on the east and south. The river enters the east side of the bay through a narrow, winding estuary. A sandy beach extends along most of the bay shoreline. Prevailing winds are from the north to northeast and the area is subject to frequent northerly storms. Thus, the most critical wave direction is from the north. The mean tidal range is 1.8 feet and the maximum range is about 4 feet.

Littoral drift within the bay is small and the littoral transport is generally in a northeasterly direction. Shoaling at the river mouth is evident, but river flow is sufficient to prevent complete blockage of the estuary. The site of the considered small boat harbor is the low-lying peninsula formed by sand and sediments between the bayshore and the river estuary. This peninsula is about 450 yards wide at the selected site and is partially occupied by a fish pond.

(2) Plan of improvement. The selected plan for development of a light-draft harbor at Hanalei Bay is shown on plate 7 and figure 7. It provides for a harbor basin to be constructed by dredging entirely within the land area comprising the north end of the peninsula between the bayshore and the river estuary. A combination entrance and main access channel would extend from Hanalei Bay into the middle portion of the peninsula to serve a berthing area of approximately 5.5 acres which would accommodate about 180 boats. The total length of the channel would be 1,800 feet. The 950 feet of channel inside the existing shoreline would be 100 feet wide and dredged to a depth of 12 feet[1/]. The entrance channel would extend 850 feet offshore to the existing 15 foot depth contour of the bay floor. The shoreward 200 feet of this outer channel would be 120 feet wide and 12 feet deep while the seaward 650-foot portion would be the same width but have a depth of 15 feet. Channel side slopes within the peninsula would require 1,450 linear feet of revetment to prevent erosion by minor wave action. Wave studies indicate, however, that the outer channel would be free of concentrated wave action and wave energy entering the access portion of the channel would be very limited. Consequently, no breakwater or protective mole would be required at this project. Dredged material from the channel and basin would be spoiled to provide a surrounding fill to an elevation of 10 feet, except on the south side of the channel where the elevation would be 6 feet. The wider portions of this fill at the northeast corner of the project would be developed for shoreside facilities. An additional 150-foot section of revetment would be necessary to protect the fill on the south side of the access portion of the channel adjacent to the beach from storm waves. A jetty would also be necessary on the south side of the entrance channel to prevent littoral drift from shoaling the channel. This jetty, to be located immediately adjacent to the existing pier, would be a rubble-mound structure 380 feet long and armored with 1-ton stone; the crest

1/ All depths or elevations cited in this report are referenced to mean lower low water (MLLW) datum.

elevation would vary from 5 to 6 feet. No jetty is considered necessary on the north side of the entrance channel because littoral drift from that direction appears negligible. Any sedimentation of the channel that might result from discharge of the Hanalei River is expected to be limited to relatively small quantities of silt.

Navigational aids would consist of a lighted beacon on the end of the existing pier and a lighted buoy located 1,800 feet off the end of the pier in line with the entrance channel which would guide craft past the reef area fringing the northeast shore of the bay and provide a range in the channel approach.

(3) Other sites considered. In considering other sites, the primary objective was to provide an all weather port since the nearest harbor is 40 nautical miles away. An alternative site in the lee of a coral reef extending from the shoreline on the west side of the bay was rejected, since the deepwater channel on the east side of the bay is the only all weather approach from the open sea. The boating group was unanimous in its opinion that the west side of the bay was untenable during severe storms. They stated also that storm waves would break over the 9 fathom mound about a half a mile offshore and that the mound apparently caused waves to build up on the west side of the bay. Local interests favored the selected site over any of the other possible locations.

b. Waianae Harbor, Island of Oahu.

(1) Description. The town of Waianae is in the lee of the Waianae Mountains on the west coast of the island of Oahu, approximately 30 road miles from Honolulu. The population in the Waianae area, including adjacent Makaha, was 6,844 in 1960. The Waianae Judicial District, the immediate tributary area of the proposed harbor, had a population of 16,452 at that time. The offshore waters along the Waianae coast are relatively calm most of the time. Prevailing winds are mild offshore trades, reduced in intensity by crossing two mountain ranges, but the afternoon winds are frequently onshore due to local convection. There are no fringing coral reef formations protecting the Waianae coastline. Approaching deepwater swells build up as they move shoreward, subjecting the coast to direct wave action. Wave studies show that the most critical conditions exist when waves approach this location from a southwesterly direction. The mean tidal range in the area is 1.8 feet, with a maximum variation of approximately 4 feet.

The proposed harbor site is immediately south of Kaneilio Point, a narrow, rocky peninsula which projects seaward about 1,000 yards in front of the town and forms the southern boundary of the waters known as Pokai Bay. A State breakwater extends into Pokai Bay

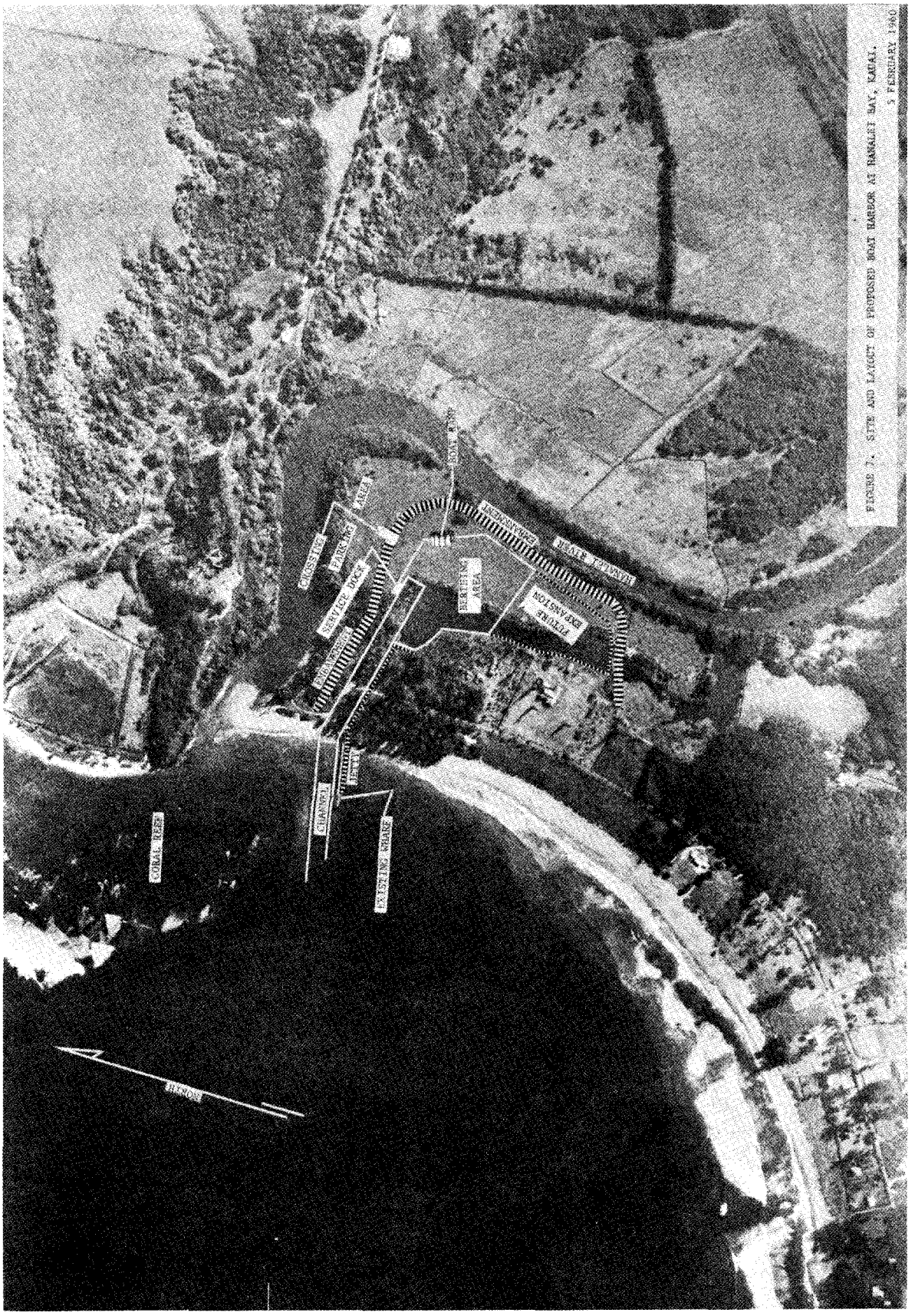


FIGURE 7. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT HANALEI BAY, KAUAI.
5 FEBRUARY 1960

from the north shore of the point, forming a protected basin used as a mooring area for about 70 small craft. Littoral drift from the north is trapped within the boat basin and frequent removal and redistribution of sand are necessary. In addition to high maintenance costs, the Pokai Bay small boat harbor conflicts with the recreational use of the adjacent beach, the best local bathing beach. For these reasons, the State plans to abandon the Pokai Bay boat basin and desires to develop a suitable small boat harbor at the site on the south side of Kaneilio Point.

(2) Plan of improvement. The proposed boat harbor at Waianae, shown on plate 8 and figure 8, is designed to accommodate approximately 380 boats. The plan provides for a generally rectangular-shaped harbor basin, approximately 10 acres in area, protected by a rubblemound breakwater, 1,350 feet long, extending in a southeasterly direction from Kaneilio Point. Two layers of 1.5-ton stone would be placed along the initial 150-foot sector at the root of the structure to a crest elevation ranging from 6 to 12 feet. Two layers of 6-ton stone would be placed to a crest elevation of 12 to 17 feet along the next 150-foot sector, while the outer 1,050 feet, including the breakwater head, would be armored with 2 layers of 7-ton stone to an elevation of 17 feet. A second protective structure in the form of a rubblemound groin 175 feet long would be located at the southeast end of the harbor basin. This groin would be armored with 1.6-ton stone to a crest elevation of 8 feet. The general navigational channels would consist of an entrance channel, 830 feet long by 150 feet wide, dredged to a depth of 17 feet for the seaward 230 feet and with a transition to 15 feet for the remaining distance; and a main access channel 870 feet long to the harbor berthing areas. The access channel would have a transition from 150-foot width and 15-foot depth in its outer portion to a 100-foot width and 12-foot depth. The proposed harbor at Waianae would be situated in an area of deepwater swells which frequently occur along the west coast of Oahu. The alignment and location of the selected entrance channel is based upon theoretical wave analysis and appears to be the most feasible of several possibilities. However, in coordination with local interests, experienced boat operators have expressed a preference for an entrance channel located at about the midpoint of the planned breakwater with a similar alignment to that of the selected channel. Considering the hydrographic factors influencing actual wave conditions in the Waianae area, and in view of the comments by local boatsmen, a model study is regarded necessary prior to the advanced engineering and design of this project in order to substantiate the selection of channel location, alignment, and depth.

The aids to navigation recommended by the Coast Guard for this project are identified in the general plan on plate 8. They include a light at the head of the breakwater and a lighted buoy, marking the entrance channel approach, to be located 470 yards southwest of the breakwater light.

The flow from the existing sanitary outfall presently discharged within the protected area of the proposed harbor basin would be extended beyond the planned breakwater. However, a sewage treatment plant for the town of Waianae is being considered at the present time. Should such a facility be realized before construction of the harbor project, the need for extension of the existing outfall would be obviated. Interior surface drainage is presently discharged into the sea just north of Glenmonger Road. This flow would be diverted to a point south of the proposed groin by a diversion ditch.

(3) Other sites and plans considered. Several alternative plans at this proposed site were considered and eliminated because of high costs of necessary protective structures, unfavorable conditions, and boat capacity limitations. Other sites along the Waianae coast were studied and were eliminated for various reasons related to adverse factors connected with land tenure, hydrography, beach usage, littoral drift conditions, or economic justification.

c. Heeia-Kea Harbor, Island of Oahu.

(1) Description. Heeia-Kea is a small community located on the northeast coast of Oahu on Kaneohe Bay approximately 3 miles from the town of Kaneohe and about 15 miles from metropolitan Honolulu. Kaneohe had a population of 14,414 in 1960. As an interim measure, the State of Hawaii has recently expanded the existing small boat facility at Heeia-Kea. With a new mole it now comprises a small enclosed basin, in addition to the single original mole, and accommodates approximately 135 craft. Variable trade winds are predominant throughout most of the year at this location. The harbor site is situated immediately northwest of the existing facility. It is well protected from the approaching deepwater swells by an extensive offshore coral reef and islet formations. The shoreline of the area is also bordered by a fringing reef formation varying in width from 500 feet to 1/2 mile, with depths from 0 to 3 feet within the reef areas. At the proposed harbor site, the width of this reef averages about 800 feet. The channel or water area of the bay proper between the offshore reef and the fringing coastal reef is over 1/2 mile wide in the vicinity of Heeia-Kea; water depths average about 42 feet in this area between the reef formations. The mean tidal range is 2.1 feet with a maximum range of about 4.5 feet. Littoral drift along the bay shore is negligible, and storm waves in the inner bay higher than 3 feet are infrequent.

(2) Plan of improvement. The most suitable plan of improvement, shown on plate 8 and figure 9, provides a tri-compartmentalized harbor of approximately 47 acres designed to accommodate 1,600 boats, which is the projected boat population of the area for the year 2010. The northern compartment would be protected by a revetted mole 1,450 feet long with a crest elevation of 8 feet. This unit of the harbor would be served by a combination entrance and access channel 570 feet

FIGURE 8. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT WAIANAE, OAHU,
5 JANUARY 1971

FIGURE 9. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT HEELA-KEA, OAHU, 20 JANUARY 1961

long, 150 feet wide, and 12 feet deep. A large central compartment would be sheltered by two revetted moles — a north mole 1,780 feet long, and a south mole 1,720 feet long, both with crest elevations of 8 feet. The southern compartment of the harbor would not require protective structures. It would be naturally sheltered from wind waves formed in Kaneohe Bay by the coral formation immediately southeast of the project site as well as by the existing mole of the present State facility. The access channel to this unit would be 150 feet long, vary in width from 150 to 280 feet, and have a depth of 8 feet. An additional dredging requirement would be the removal of a coral head partially obstructing the approaches to the channel into the central compartment of the harbor. This obstruction would be reduced to a depth of 12 feet. Each revetted mole would be armored with 2 layers of 600-pound armor stone. Navigational aids would consist of two lighted buoys — one each to mark coral outcrops near the northern and southern entrance channels.

(3) Other sites considered. Local interests desired expansion of the existing boat facility at Heeia-Kea. Furthermore, no other site in Kaneohe Bay offered any more advantageous conditions.

d. Kailua Harbor, Island of Oahu.

(1) Description. The town of Kailua occupies a flat sandy plain on the windward or east shore of the island of Oahu, approximately 12 miles from Honolulu. Kailua and adjacent Lanikai had a combined population of 25,672 in 1960. The town fronts on Kailua Bay, a sizable open bay sheltered from high waves by an offshore barrier reef. An extensive marshy depression, a former natural lagoon known as Kawainui Swamp, is situated directly behind Kailua. The marsh is being considered for development as a park area, but is presently used only to a limited degree for livestock grazing. During wet periods the marsh receives and temporarily retains a large amount of runoff. The Oneawa Channel was constructed as a temporary flood control measure in 1951 by the State of Hawaii to alleviate the recurring flood damages to the rapidly expanding town of Kailua. It drains the north portion of the marsh while drainage from the south side is through a natural stream.

The Kawainui Swamp Flood Control Project was authorized by Congress in May 1950 and the recommended plan of improvement is presented in "Design Memorandum, Kawainui Swamp, Oahu," dated June 1957. It basically consists of improving the Oneawa Channel, which would have a minimum bottom width of 80 feet and a minimum depth of 6 feet, and providing a levee 10 feet high to protect Kailua from overflow on the swamp side of the town.

Prevailing winds in the area are northeasterly trades. Wave action in Kailua Bay near the Oneawa Channel entrance is minor. Small craft presently utilizing the channel have little difficulty entering or leaving the entrance. The mean tidal range in Kailua Bay is about 1.8 feet with a maximum range of about 4 feet. Shoaling at the entrance into the channel is minor.

36-957 O-64—5

(2) Plan of improvement. Because of the existing Kalaheo Avenue bridge across the Oneawa Channel, the Kailua Harbor project would be restricted for the use of power boats no greater than 20 feet in length with drafts not greater than 4 feet and with hull structures or appurtenances not extending more than approximately 5.5 feet above the water line. Small craft within these size limits are generally the type presently operated in Kailua Bay. The recommended harbor with a capacity of 820 boats, shown on plate 8 and figure 10, is contingent on the flood control improvements being constructed prior to, or concurrently with, the harbor improvements. The existing Oneawa Channel, about 1-3/4 miles long, enters the north end of Kailua Bay at Kapoho Point. The channel is now inadequate for use as an access channel to the site of the proposed harbor and must be dredged and maintained as presented in the Kawainui flood control plan if it is to be used for that purpose. The flood control plan would provide an entrance channel 110 feet wide and 9 feet deep extending from about 500 feet seaward of the channel mouth to about 1,300 feet inland. The remaining length of the channel would have a minimum width of 80 feet and a minimum depth of 6 feet. A beacon as an aid to navigation would be located on Kapoho Point near the mouth of Oneawa Channel to provide guidance into the channel.

Harbor dredging would create a maneuvering basin of approximately 120,000 square feet plus a main access channel 1,800 feet long, varying from 100 to 150 feet in width. The project depth would be 6 feet. Floating piers would be effective in the berthing area at this facility in that the piers would not interfere with flood water exit to the sea. No protective structures would be necessary because of the interior location. Land areas for service facilities and parking would be created by placing fill to an elevation of 6 feet. Landside access to the facilities would be by way of ramps over the flood control levee and down into the service and parking areas. Construction of this facility would eliminate some of the mosquito producing area and facilitate further corrective measures such as drainage of adjoining swamp areas.

(3) Other sites considered. Preliminary studies were made of several alternative sites within Kailua Bay but no comparably satisfactory site was found. A protected boat harbor in the bay, as suggested by local interests during the public hearing in 1959, would necessitate costly breakwater and mole construction, as well as constituting an adverse influence upon the excellent bathing beach extending along the shore. Harbor structures and channels would cause a disruptive effect on littoral drift along the beach. Total costs would exceed potential benefits. Property acquisition in the high-class residential zone along the shore would be prohibitively high, except at the existing public beach park. Development at the park would conflict with present bathing and recreational use. Several other locations within the Kawainui Swamp area were also

investigated. The proposed site was selected because of ready accessibility by both boats and automobiles. Most other areas of the swamp are less accessible by established roads or are farther from the sea. Subsurface conditions and hydrology factors indicate that a stable and satisfactory harbor can be constructed at the proposed site, whereas conditions in other areas of the marsh are of questionable feasibility in view of probable drainage and development actions likely to be forthcoming in connection with development of the area. The proposed harbor project would also be compatible with the authorized flood control project.

e. Maunalua Bay Harbor, Island of Oahu.

(1) Description. Maunalua Bay, located near the southeastern tip of Oahu, constitutes the embayment fronting the eastern suburbs of the city of Honolulu between Wailupe Peninsula and Koko Head mountain. Honolulu had a population of 294,194 in 1960. The harbor site under consideration is approximately 11 miles from the center of the city. Rapid residential expansion is in progress along the shore of Maunalua Bay and in the adjacent valleys.

Coral formations within the bay extend seaward about 2,800 feet in the area of interest. Deepwater waves break on the seaward slope of the reef. Water depths vary over this reef area from about 1 foot to 6 feet. Depths in excess of 20 feet are found approximately 400 feet from the edge of the reef formations. The mean tidal range in Maunalua Bay is 1.9 feet with a maximum range of about 4.0 feet. Prevailing winds are moderate to strong from the north and northeast and gusty winds are funneled into the bay area between the mountain ridges.

A channel for small craft has been dredged by a private concern into a marina complex connected with the Hawaii-Kai housing development presently under construction in the Kuapa Pond area inland of the proposed site.

(2) Plan of improvement. Maunalua Bay affords very favorable conditions for small-boat harbor development. The shallow reef area extending into the bay gives natural protection to the inshore area against severe wave action. The proposed plan of improvement, shown on plate 8 and figure 11, would provide a protected harbor basin of approximately 44 acres with a berthing capacity for about 950 craft. East and west revetted moles, 2,900 and 1,950 feet in length respectively, would inclose the basin. The revetted outer portions of these moles would be armored with .65-ton stone and have crest elevations of 9 feet. An entrance channel, 870 feet long and 200 feet wide, would extend seaward in a southerly direction from a widened channel section of approximately 370,000 square feet. The selected channel alignment minimizes the distance to deep water. This channel would be 200 feet wide; depths

would vary from 20 feet in the outer 300-foot reach to 15 feet for the remaining distance to the widened channel section which would also be dredged to a depth of 15 feet. The outer entrance channel depth of 20 feet would reduce occurrences of waves breaking in the channel which extends across the reef through the surf zone. The 200-foot channel width would preclude congestion within the channel when the maximum utilization of the harbor by 950 craft is attained. Space requirements for the craft traversing the main navigation channel from the private marina were also taken into account in selecting this width. A 200-foot channel width is considered essential to sailboat tacking and to facilitate evacuation of the large number of based craft during tsunami alerts.

A dredged access channel from the turning basin to the west entrance of the private Hawaii-Kai marina would be provided by local interests since the landside fill area for parking and onshore facilities connected with the proposed project would block off the existing channel.

A lighted buoy, two channel lights, and a mole light would be provided as navigational aids into the entrance channel and harbor.

(3) Other sites considered. Several alternative sites within Maunalua Bay were considered as possible locations for a harbor facility, but none offered as suitable conditions or as favorable a land situation as the proposed site.

f. Lahaina Harbor, island of Maui.

(1) Description. Lahaina, with a population of approximately 3,500, is located on the west coast of Maui, about 22 road miles from Wailuku, the Maui county seat. It is the third largest town on the island, next in size to Kahului and Wailuku, both located on the northern side of Maui. As a historic whaling center and first capital of Hawaii, Lahaina is becoming increasingly important as a tourist attraction. The Lahaina Judicial District, the tributary area of the proposed project, had a population of 4,844 in 1960. A major destination resort opened in 1963 at Kaanapali, a few miles north of the town. Lahaina Roads, the local waters of the Auau Channel between Maui and the island of Lanai, is relatively calm most of the year and affords one of Hawaii's best

FIGURE 11. SITE AND LAYOUT OF PROPOSED BOAT BASINS AT SANDUSKY, OHIO.

recreational boating areas. Consequently, Lahaina is a traditional stopping place for cruising craft running up and down the island chain. An 80,000 square-foot harbor, located adjacent to the center of town, can accommodate about 30 small boats. The existing small-craft harbor is protected by a 1,000-foot breakwater seated on the coral reef fronting the town. Local interests wish to remove the existing harbor after the new harbor is operational to conform with plans for the historical restoration of Lahaina.

Gentle variable winds predominate throughout most of the year along the coast in the Lahaina area. Lahaina is protected from northerly storms and gusty trade winds by the West Maui mountains, but is exposed to the southerly storms of the winter season. However, the coastline in the vicinity of Lahaina is fringed by a coral reef which causes high waves to break before reaching the shore. The reef extends seaward approximately 850 feet from the shoreline at the proposed project site. The mean tidal range is 2.0 feet with a maximum range of about 4 feet. The existing shoreline at the site of the proposed project is protected by a concrete seawall.

(2) Plan of improvement. The proposed plan of improvement is shown on plate 9 and figure 12. It provides for a new harbor with an interior basin of about 5.3 acres to be located immediately northwest of the small existing facility. The harbor basin, designed to accommodate 160 boats, would be protected by an offshore breakwater 950 feet long, with a crest elevation of 10 feet, and by a revetted mole 620 feet long with a crest elevation of 9 feet. The offshore breakwater would be a rubblemound structure with two layers of 1-ton armor stone on the trunk and 1.1-ton stone on the heads. The revetment on the seaward side of the mole would be 0.6-ton stone. The plan allows for a gap 120 feet wide between the northwest end of the offshore breakwater and the end of the revetted mole to facilitate tidal flushing of the berthing area and to reduce surge in the harbor basin.

An entrance channel 515 feet long and 150 feet wide would be dredged to a depth of 20 feet in the seaward 230-foot reach and to a depth of 15 feet for the remaining distance. This channel would extend in a southwesterly direction from a turning basin and main access channel with a combined water surface of 140,000 square feet. The proposed entrance channel would overlie most of the existing 12-foot channel to the present boat harbor, reducing the amount of dredging necessary for that part of the project. Wave analysis shows the channel to be outside the region of wave convergence. However, a 20-foot depth in the outer channel is considered necessary to reduce the occurrence of storm waves breaking in the channel. A wave absorber 180 feet long consisting of 2 layers of 300-pound armor stone placed on coral fill would be situated at the shoreward end of the channel to reduce reflected wave energy in the turning area.

In addition to the existing lighted channel buoy located 700 yards offshore and the Lahaina lighthouse located on shore, two buoys and a breakwater light would be provided as additional aids to navigation into the proposed harbor.

(3) Other sites considered. Mala, approximately 1 mile northwest of Lahaina, was considered as an alternate site. However, the reef area at Mala is narrow, and provision of a harbor of adequate size would necessitate constructing a breakwater in water depths of 12 to 18 feet, as compared with depths of less than 4 feet at Lahaina. Preliminary cost comparisons showed that the greater expense of breakwater construction at Mala would substantially increase the project first cost. Therefore, the Mala site was dropped from further consideration.

g. Hana Harbor, Island of Maui.

(1) Description. The small town of Hana is relatively isolated on the east coast of Maui, approximately 59 road miles from Wailuku, the county seat. Beef raising provides the economic base for the area and involves one large ranch and several smaller establishments. Population in the Hana district totaled approximately 1,100 persons in 1960. The coastline of East Maui is rugged and in many areas access by land is difficult or impossible. High waves attack the shoreline through much of the year. Hana Bay, a semicircular pocket embayment with an entrance about 3/4 of a mile wide, faces due east. The prevailing winds are trades from the east and northeast. Seas run from the east approximately 41 percent of the time, and from the northeast approximately 24 percent of the time. Wave refraction studies show that the most critical direction of wave attack would be from due east. The mean tidal range in Hana Bay is 2.5 feet with a maximum range of about 4.5 feet.

(2) Plan of improvement. The proposed plan of improvement is shown on plate 9 and figure 13. It provides for a fishing and recreational boat harbor in combination with a commercial barge terminal and is intended to accommodate approximately 80 based craft. The Federal project would require construction of only one feature consisting of a breakwater 1,230 feet long, of which the landward 250 feet would be in the form of a revetted mole. This structure would shelter a turning area and harbor basin of about 200,000 square feet. The revetted mole section of the breakwater would be armored with 2 layers of 1.5-ton stone and have a crest elevation varying from 7 to 13 feet. The inner breakwater trunk from station 2+50 to station 4+50 would be armored with 2 layers of 2.5-ton stone, and the crest elevation would vary from 13 to 17 feet. The outer trunk, from station 4+50 to station 10+80, would have 2 layers of 6-ton armor stone to a crest elevation of 17 feet. The head of the breakwater and the transition section beyond station 10+80 would be protected by 10-ton stone and have a crest elevation

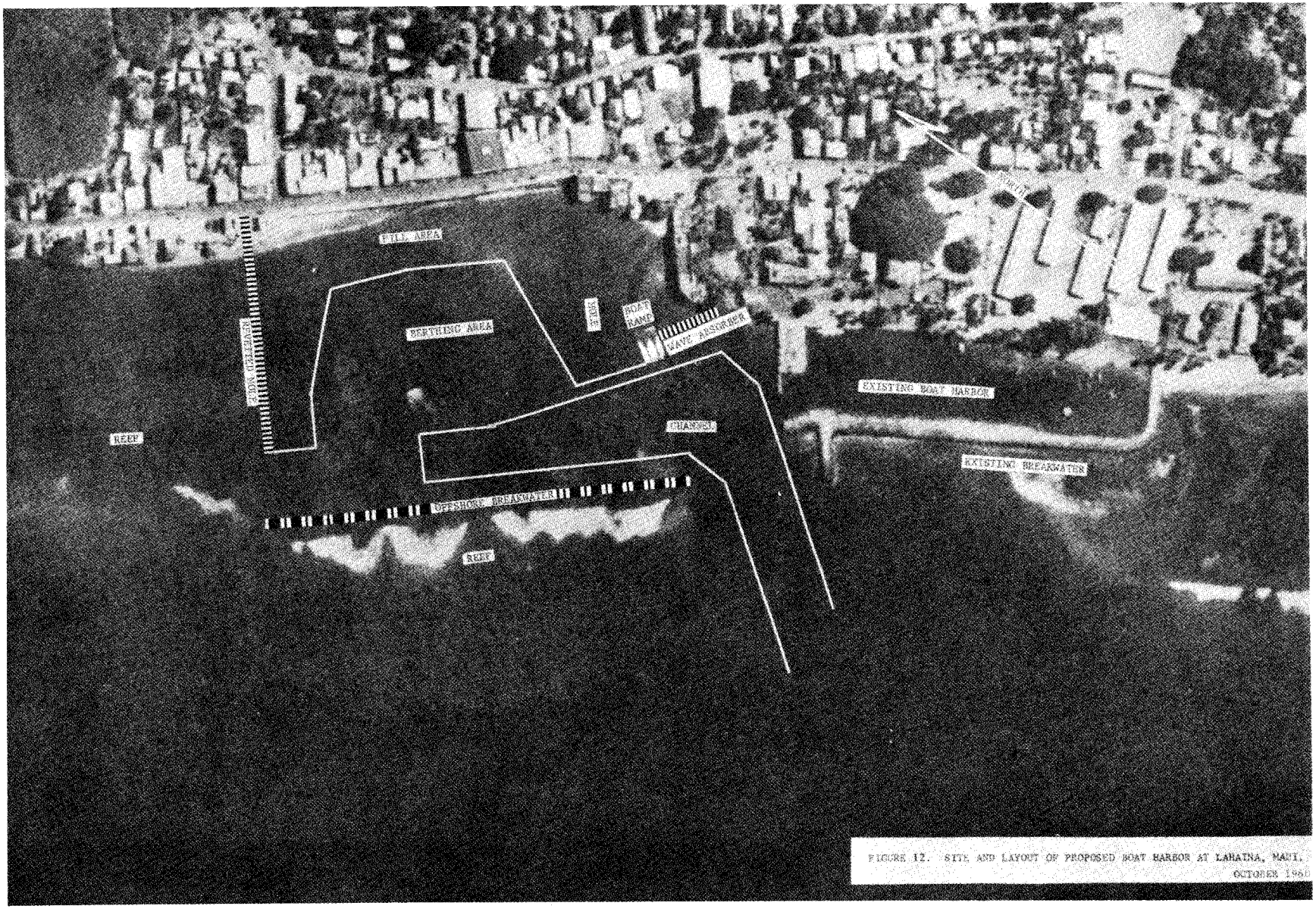


FIGURE 12. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT LAHAINA, MAUI.
OCTOBER 1980

FIGURE 13. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT HANA, MAUI.
OCTOBER 1960

varying from 17 to 20 feet. The breakwater alignment shown on the general plan was selected to utilize the shallower existing depths in the bay for placement of the structure as well as to provide for an adequately protected area of sufficient size for interisland barge operations.

Depths within Hana Bay are adequate to meet the draft requirements of small craft and commercial tugs and barges of the type expected to use the harbor so that no initial dredging would be required at the project. The existing natural channel would afford a minimum width of 200 feet in the vicinity of the head of the proposed breakwater. Minimum depths in that area and along the outer side of the proposed barge pier would be 18 feet. Depths from 18 to 8 feet prevail in the proposed basin area of the inner harbor which would be utilized for small-craft berthing and access. Infrequent dredging in the natural entrance and barge turning area might be necessary to maintain a minimum project depth of 17 feet. Open-pile pier construction of the barge terminal by local interests may be desirable in order to avoid reflected wave energy in the barge berthing and turning area.

The required aids to navigation at the Hana project would consist of a breakwater light at the head of the structure; a lighted buoy, marking a shoal area, to be located approximately 600 feet southeast of the breakwater light; and a lighted buoy to mark another shoal area about 1,600 feet east of the breakwater head.

Wave analysis indicates that the planned breakwater would satisfactorily protect the harbor from approaching deepwater waves. However, Hana Bay, being directly exposed to the prevailing trade winds, experiences frequent periods of high or relatively high waves. Consequently, an engineering model study is considered necessary to verify the design and to determine more accurately the degree of surge that could actually be expected to occur within the planned harbor basin at the proposed barge terminal. Should objectionable surge conditions be identified from the model observations, remedial adjustments in the proposed plan, such as lengthening the breakwater, providing spending beaches, or changing the location of the barge pier, prior to advanced engineering and design of this project, would be made. Modification of the proposed harbor plan might result in a moderate increase in the project cost; however, the economic justification of the project would not be jeopardized.

h. Reeds Bay Harbor, Island of Hawaii.

(1) Description. Hilo, the county seat and port city of Hawaii County, is located on Hilo Bay on the northeast coast of the island of Hawaii. The second largest city in the State, Hilo had a 1960 population of about 26,000. Reeds Bay, a small inlet in the shoreline of Hilo Bay, is within the city limits. It is located

shoreward of the existing Federal deepwater harbor which is protected by a long breakwater. Thus, Reeds Bay is sheltered from direct attack by deepwater waves but may be subjected to 5-foot wind waves generated in Hilo Bay. The floor of Reeds Bay is composed of hard lava formations with a superficial layer of silt and sand, and the shore is rocky except for a short sandy beach at its west end. Prevailing winds in the area are light to moderate from the south and southwest.

(2) Plan of improvement. The plan of improvement considered most suitable for a small-boat harbor at Reeds Bay is shown on plate 7 and figure 14. It provides for a breakwater, 870 feet long, extending eastward from the existing shoreline to shelter a flared harbor basin of about 9 acres in area and suitable for the accommodation of approximately 270 boats. The breakwater would be armored with 2 layers of 700-pound stone and have a crest elevation of 8.5 feet. A dredged entrance channel, 880 feet long, would extend south from the existing project line of the Hilo deepwater harbor to the mouth of the proposed basin between the breakwater head and the point of shoreline marking the southeast corner of the inlet which forms Reeds Bay. The straight entrance channel would be 120 feet wide and 12 feet deep. Navigational aids as indicated on the general plan would consist of a breakwater light at the head of the structure and a lighted buoy and day beacon identifying the seaward and landward ends of the entrance channel.

(3) Other sites considered. Radio Bay on the east side of Hilo Harbor pier No. 1 was considered as a possible alternate location for a small-boat harbor. However, the State of Hawaii opposed the use of this area in view of possible expansion of commercial terminal facilities. The site was therefore excluded from further consideration. Another site, within the Wailoa River estuary approximately 4,000 feet southwest of Reeds Bay, was also investigated for development of a small-craft facility. This area is adjacent to the existing commercial sampan basin presently used by fishing boats. This area is subject to a considerable change in water surface during flood periods of the Wailoa River. Use of this site would also entail raising and modifying the existing highway bridge to provide adequate clearance for the passage of small craft. The costs of improvements would be greater than the justified benefits of the project; therefore this site was also eliminated.

15. SHORELINE CHANGES

No significant shoreline changes in the form of erosion or accretion are anticipated from construction of any of the eight light-draft harbors proposed in this report. In all instances the project structures and channels would be so situated as to have very little, if any, physical effect on prevailing littoral drift.

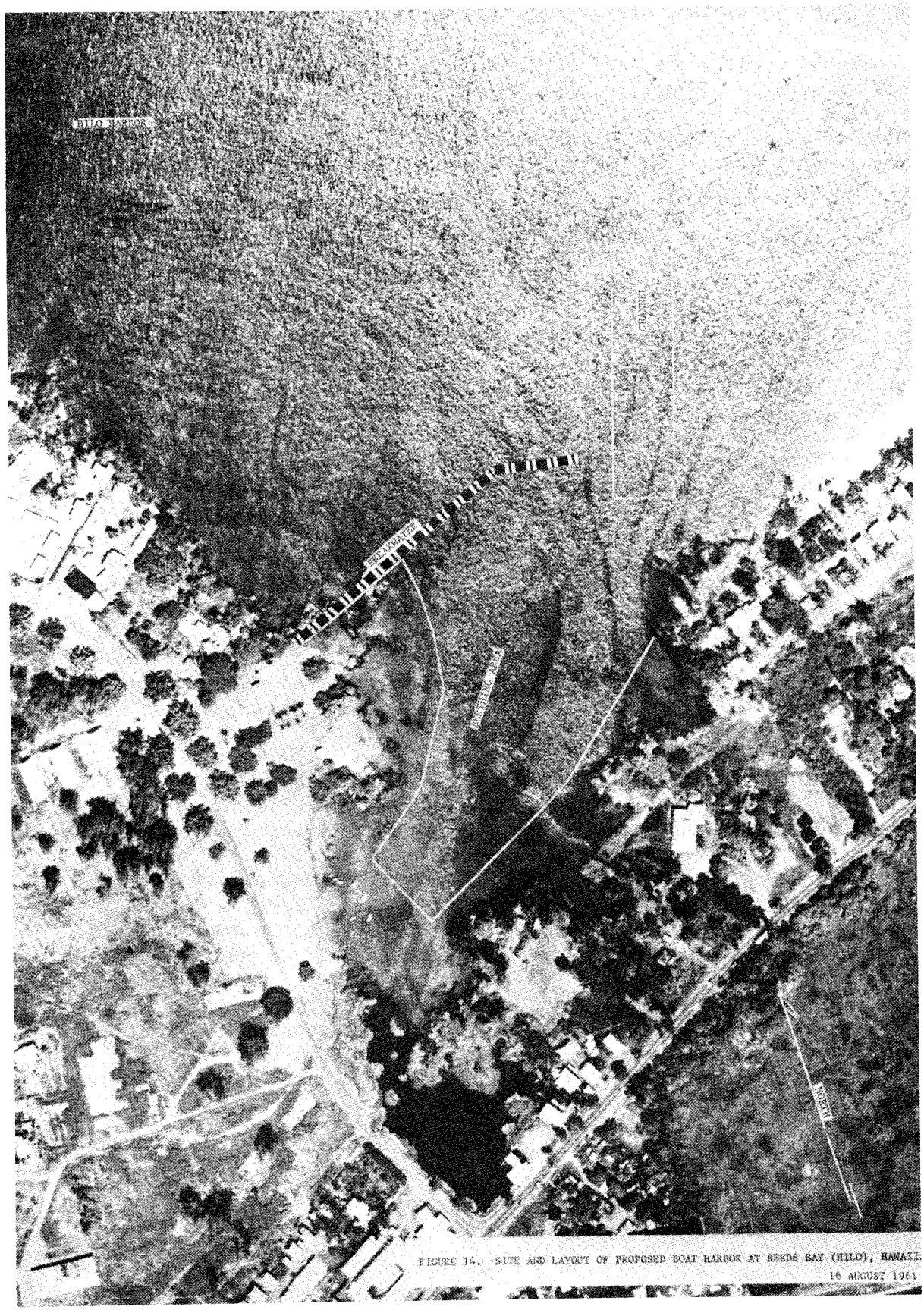


FIGURE 14. SITE AND LAYOUT OF PROPOSED BOAT HARBOR AT REEDS BAY (HILO), HAWAII.
16 AUGUST 1961

16. REQUIRED AIDS TO NAVIGATION

Plans for the proposed light-draft navigation improvements were forwarded to the Commander, Fourteenth Coast Guard District, for determination of the type, location, and estimated first and annual costs of necessary aids to navigation at each harbor project. The Coast Guard recommended the type and location of aids indicated on the general plans.

ECONOMIC ANALYSIS

17. ESTIMATE AND APPORTIONMENT OF FIRST COSTS

The estimated first costs of the proposed plans of improvement, excluding self-liquidating items, are shown in table 13. The estimates of the direct construction costs include a 20 percent allowance for contingencies and are based on November 1962 price levels in Hawaii. The apportionment of first costs between Federal and non-Federal interests is also indicated in the same table. Those costs connected with the provision of berthing and mooring areas and facilities and the local access channels thereto, together with those costs involved in the development of all other onshore structures and facilities necessary to insure a complete and adequate project, are considered self-liquidating costs to be borne by local interests and are not included in the project first costs. The apportionment of project costs is based on the policy that the first costs of providing the improvements shall be divided between the Federal government and local interests in direct and identical proportion to the forthcoming general and local benefits.

18. ESTIMATE OF AVERAGE ANNUAL CHARGES

Table 14 shows the average annual charges computed from the estimated costs of the eight proposed projects. The annual carrying charges indicated are based on a 50-year amortization period covering the assumed useful life of each project. The interest rate used for the Federal and non-Federal investments is 3 percent. Average annual maintenance charges are included for the estimated Federal cost of maintaining all general navigation channels and the protective structures at each project. There is no non-Federal maintenance charge for these navigation and protective features. Amortization of the project costs over a greater period than a 50-year project life is not considered significant in determining project feasibility nor would it result in change in scope of the projects or the basis for cost-sharing arrangements.

Table 13

Estimate of First Costs and Apportionment of Costs Between Interests
(In Thousands of Dollars)

Project	Total first cost	Federal							Non-Federal			
		Corps of Engineers					Coast Guard					
		Protective structures	Dredging[1/]	Engineering & design	Supervision & administration	Net cost to Corps[2/]	Aids to navigation	Total Federal (net)	Lands, easements, rights-of-way[3/]	Relocations[3/]	Cash contributions	Total non-Federal
Island of Kauai												
Hanalei Bay	$ 887	$ 259	$311	$ 36	$ 63	$ 347	$10	$ 357	$208	-	$322	$530
Island of Oahu												
Waianae	1,877	1,434	144	83	133	933	10	943	65	$8	861	934
Heeia-Kea	851	428	281	34	65	409	5	414	38	-	399	437
Kailua	735	-	406	36	45	243.5	6	249.5	242[4/]	-	243.5	485.5
Maunalua Bay	1,188	595	304	41	83	513	18	531	147	-	510	657
Island of Maui												
Lahaina	721	211	378	35	61	364	13	377	23	-	321	344
Hana	1,884	1,590	-	117	132	1,679	16	1,695	29	-	160	189
Island of Hawaii												
Reeds Bay (Hilo)	531	327	86	34	49	248	9	257	26	-	248	274

1/ Dredging costs contain a minimum allowance for overdepth dredging.
2/ Total first cost of construction less the non-Federal cash contribution.
3/ Includes estimated indirect costs.
4/ Includes dredging of access channel.

Table 14

Estimates of Average Annual Charges
(In Thousands of Dollars)

Project (1)	Total annual charges (2)	Federal					Non-Federal			
		First cost (3)	Interest at 3 percent (4)	Amortization @ 0.887 percent (5)	Maintenance (6)	Total (7)	First cost (8)	Interest at 3 percent (9)	Amortization @ 0.887 percent (10)	Total (11)
Island of Kauai										
Hanalei Bay	$36.5	$ 357	$10.7	$ 3.2	$ 2.0	$15.9	$530	$15.9	$4.7	$20.6
Island of Oahu										
Waianae	85.0	943	28.3	8.4	12.0	48.7	934	28.0	8.3	36.3
Heeia-Kea	38.1	414	12.4	3.7	5.0	21.1	437	13.1	3.9	17.0
Kailua	34.6	249.5	7.5	2.2	6.0	15.7	485.5	14.6	4.3	18.9
Maunalua Bay	54.6	531	15.9	4.7	8.5	29.1	657	19.7	5.8	25.5
Island of Maui										
Lahaina	32.9	377	11.3	3.3	5.0	19.6	344	10.3	3.0	13.3
Hana	88.2	1,695	50.8	15.0	15.0	80.8	189	5.7	1.7	7.4
Island of Hawaii										
Reeds Bay (Hilo)	24.6	257	7.7	2.3	4.0	14.0	274	8.2	2.4	10.6

19. ESTIMATE OF BENEFITS

a. General. The tangible benefits that are expected to accrue to the eight proposed harbor projects over their assumed useful economic life of 50 years would consist predominately of those derived from recreational boating, increased commercial fish catch, prevention of boat damages, and land enhancement. Significant commercial transportation benefits would result only from the proposed harbor at Hana, Maui. This type of activity is not foreseen for the other harbors. The total recreational benefits anticipated are considerably more substantial than those expected from commercial fishing. This is because the majority of the existing and future fishing vessels are expected to operate from established facilities or other planned harbors not included among the Federal projects proposed herein. Land enhancement benefits would accrue from new land created by spoil disposal of dredged material at the proposed harbors, except at Hana where no Federal dredging is required and at Waianae where the cost of creating new land would exceed the gross market value of the land.

Significant intangible benefits, not subject to monetary evaluation, would also result from the proposed projects, particularly as related to the prevention or reduction of injury and loss of life and to the promotion of the public welfare and enjoyment.

Sample computations for each category of monetary benefit expected to accrue to the harbors proposed for Federal participation are contained in appendix B. The total dollar values of the estimated benefits derived for each project are presented by category in table 15.

b. Benefits from recreational boating. Average annual recreation boating benefits for the eight proposed harbors were computed for the projected numbers of craft anticipated to use the facilities in the initial project year, assumed to be 1965, and for the years 1980 and 2010. Projections were made for these years using two growth rates - the expected growth rates in the boat population of each project tributary area with and without the proposed improvements. The numerical projections of the boat population expected to be based at each project, which reflect the higher of the two growth rates, are given for the three selected levels of development in table 10 in section 13 of this report. In deriving the number of craft expected to use the proposed improvements, the basic factors employed were the population and per capita income projections developed for each judicial district of the State as shown in appendix C and summarized by island in table 3 of this report. Due regard was also given to national growth trends in the field of small boating and the economic considerations related thereto. These projections for the years 1965, 1980, and 2010 are indicative of the intermediate usage and eventual full utilization of each proposed light-draft facility. It is expected that the growth rate of the future boat population will level off and remain essentially static for the last 5 years of the assumed 50-year economic lives of the projects. From the projected boat populations and their breakdowns by general categories of recreational craft for each selected level of

36-957 O-64—6

development, average annual benefits were derived for private recreational craft, both based and launched at the harbor, for based charter boats used for sports fishing or recreational cruising, and for transient recreational craft which could be expected to regularly use a portion of each harbor's berthing facilities. Damage prevention benefits were also developed for the existing craft and for the number of future craft which can be expected to be forthcoming because of the natural growth rate in the boat population of the locality without the protection afforded by the proposed project. The benefits thus computed, by use of the Corps of Engineers standard recreational boating formula, are summarized in table 15. Further detail is provided in appendix B.

c. Benefits from commercial fishing. Because of the present static condition and apparently limited growth prospects of the fishing industry in Hawaii, the fishing benefits likely to accrue to the proposed small-boat projects are not great in comparison with the overall recreational benefits expected. Studies of commercial fishing operations conducted in support of this survey concluded that the provision of new light-draft vessel harbors would have a modest stimulating effect on expansion of the existing fishing fleet. However, it was concluded that, although a few of the existing boats would shift their bases of operations, the availability of new harbors would cause relatively little overall change in present operating patterns. In contrast, the growth of recreational boating is virtually certain to be stimulated substantially by additional facilities being made available. Consequently, two of the eight proposed projects (Kailua on Oahu and Reeds Bay on Hawaii) are planned only as recreational boat bases. Foreseeable commercial fishing benefits at the five other projects would result from the increased fish catch attributable to the navigation improvements and from the future damages prevented to those fishing craft currently based at the sites. Increases in the number of fishing trips presently possible would result from the greater protection and more efficient and suitable facilities to be afforded by the improvements. In addition, construction of the proposed project at Hana on Maui would allow restoration of commercial fishing at that site. Hana was abandoned as a fishing base in 1954 because of recurring heavy damages to fishing craft attributable to inadequate shelter. In computing the probable monetary benefits from increased fish catch, an estimate was made of the potential number of increased trips per annum which might be credited to the considered harbor improvements. Benefits per trip were then derived by subtracting the average operating cost per trip from the average value of the catch. The total estimated commercial fishing benefits, including prevention of vessel damage and loss of gear, are shown for each proposed project in table 15.

d. Benefits from prevention of vessel damages. Representative monetary damages sustained by approximately 8 percent of the State's recreational craft were determined from owner interviews. This sampling indicated that 126 boats suffered over $75,000 in damages during one year entirely from inadequate harbor facilities. The damages resulted from overcrowding, lack of protection, dangerous navigation channels, and launching accidents due to the lack of satisfactory ramps

in many areas. Application of the sample to the total recreational fleet shows that some 1,660 boats suffer annual damages totaling approximately $274,000. Available data on fishing boat damages is less complete and insufficient for a thorough annual damage analysis. Therefore, the same figure for average annual damages per boat used for recreational craft was applied to obtain the damage prevention estimate for commercial fishing craft. This approach is definitely conservative since the average fishing craft is generally operated much more frequently than the average recreational boat. This greater use raises the chance of operational accidents stemming from unsafe harbor conditions. The damage prevention benefits estimated for each of the proposed projects are consolidated with the recreational and commercial fishing benefits given in table 15.

e. Benefits from savings in commercial water transportation costs. The proposed project at Hana, Maui, would include a new 300-foot barge pier to be used in place of the exposed and deteriorated existing pier. This new facility would allow regular barge calls at Hana from Honolulu for shipments of live cattle and chilled beef and imports of cattle feed, retail goods, and petroleum products. Only occasional imports of bulk petroleum products are now made at Hana because of the unsafe and inadequate terminal. The other imports and exports, except the chilled beef, are moved by truck 55 miles to and from the deep-draft harbor at Kahului over a difficult road for transshipment to the Honolulu barge service. The chilled beef is shipped by air. Direct barge movement of these items would result in transportation savings of $85,000.

f. Benefits from land enhancement. Annual benefits from spoil used to create lands are summarized in table 15. These excess lands would become the property of local interests. Local interests are thus required to make a cash contribution toward construction costs based on a ratio of enhancement benefits to total project benefits. The enhancement values used for benefit computations were taken as the lesser amount between the net market value and the cost of creating the land by equivalent fill.

g. Intangible benefits. As a factor in preventing or reducing loss of life, injuries, and damages to existing and future craft, the storm refuge and emergency value of the proposed harbors should be given due consideration in project justification. All of the eight projects would have major value in this respect, but the most important would be the projects at Hanalei Bay, Kauai, and at Hana, Maui. They would provide the only safe havens for small craft along the entire north coast of Kauai and along the whole eastern coastline of Maui. Both areas offer good fishing grounds and attractive recreational boating waters in good weather. However, the surrounding waters are notably exposed to the prevailing trades, which frequently generate dangerous seas, and to squalls and major storms.

Table 15

Summary of Average Annual Benefits
for 50-year Project Life

Considered project location	Design capacity (approx no. of boats)	Full utilization attained (year)	Recreational benefits[1/] ($)	Land enhancement benefits ($)	Commercial fishing benefits[2/] ($)	Commercial transportation benefits ($)	Total ($)
Island of Kauai:							
Hanalei Bay	180	2010	$40,500	$5,000	$1,600	0	$ 47,100
Island of Oahu:							
Waianae	380	2010	92,200	0	3,900	0	96,100
Heeia-Kea	1,600	2010	201,800	7,000	2,500	0	211,300
Kailua	680	2010	44,300	8,400	0	0	52,700
Maunalua Bay	950	2010	223,200	8,400	600	0	232,200
Island of Maui:							
Lahaina	160	2010	42,800	1,700	2,900	0	47,400
Hana	70	2010	18,700	0	3,100	$85,300	107,100
Island of Hawaii:							
Reeds Bay (Hilo)	270	2010	52,700	600	0	0	53,300

1/ and 2/ Related damage prevention benefits included.

h. Apportionment of benefits. The distribution of the total estimated average annual monetary benefits between general and local categories is shown in table 16 for each proposed project. By established policy, potential recreational benefits are treated as half general and half local in nature, whereas commercial fishing and water transportation benefits are regarded as all general. Local benefits accrue to the State of Hawaii; general benefits to the public welfare and hence to the Federal Government.

Table 16

Summary of Average Annual Benefit Apportionment to General Navigation and Recreation 1/

Project	General benefits		Local benefits		Total
	Value	Percent of total	Value	Percent of total	
Island of Kauai:					
Hanalei Bay	$21,850	51.9	$20,250	48.1	$42,100
Island of Oahu:					
Waianae	50,000	52.0	46,100	48.0	96,100
Heeia-Kea	103,400	50.6	100,900	49.4	204,300
Kailua	22,150	50.0	22,150	50.0	44,300
Maunalua Bay	112,200	50.1	111,600	49.9	223,800
Island of Maui:					
Lahaina	24,300	53.2	21,400	46.8	45,700
Hana	97,750	91.3	9,350	8.7	107,100
Island of Hawaii:					
Reeds Bay (Hilo)	26,350	50.0	26,350	50.0	52,700

1/ Excludes land enhancement which is allocated 50 percent general and 50 percent local.

20. COMPARISON OF BENEFITS AND COSTS

The economic justification for the eight projects is shown in table 17 which compares the anticipated average annual benefits and charges and gives the resulting benefit-cost ratios for each plan of improvement.

Table 17

Comparison of Benefits and Costs

Project	Total average annual benefits	Total average annual charges	Benefit-cost ratio
Island of Kauai:			
Hanalei Bay	$47,100	$36,500	1.3 to 1
Island of Oahu:			
Waianae	96,100	85,000	1.1 to 1
Heeia-Kea	211,300	38,100	5.5 to 1
Kailua	52,700	34,600	1.5 to 1
Maunalua Bay	232,200	54,600	4.2 to 1
Island of Maui:			
Lahaina	47,100	32,900	1.4 to 1
Hana	107,100	88,200	1.2 to 1
Island of Hawaii:			
Reeds Bay (Hilo)	53,300	24,600	2.2 to 1

RESULTS OF INVESTIGATIONS

21. REQUIRED LOCAL COOPERATION

Federal participation in the construction and maintenance of the eight light-draft harbor projects described herein will be subject to the condition that local interests will, as applicable to each project, satisfy the following requirements:

a. Provide without cost to the United States all lands, easements and rights-of-way required for construction and subsequent maintenance of the projects and for aids to navigation upon the request of the Chief of Engineers, and suitable areas determined by the Chief of Engineers to be required in the general public interest for the

initial and subsequent disposal of spoil, and also necessary retaining dikes, bulkheads and embankments therefor or the costs of such retaining works.

b. Provide and maintain without cost to the United States necessary berthing or mooring areas, installations, and utilities, including a public landing with suitable supply facilities open to all on equal terms. Additionally, at Hana, Maui, provide and maintain an appropriate public terminal with whatever facilities are deemed essential to serve the anticipated commercial transportation operations at that harbor.

c. Provide and maintain without cost to the United States depths in the berthing and mooring areas, and in the local access channels thereto, commensurate with the depths provided in the related project areas.

d. Provide and maintain without cost to the United States all appropriate onshore structures, access roadways, parking areas, public restrooms, and trailer-mounted boat launching ramps as necessary to insure a complete and adequate project.

e. Accomplish without cost to the United States such utility, drainage, or other relocations or alterations as necessary for project purposes.

f. In view of local benefits anticipated from the projects, make an equitable cash contribution prior to commencement of construction towards the Federal first cost of each project (excluding aids to navigation) in a lump sum expressed as a percentage of the estimated Federal first costs. (The presently estimated amounts of the required cash contributions are shown for each proposed project in table 13 on page 65 of this report. These estimates are not considered fixed dollar amounts at this time, but are included for information and will be adjusted to the actual costs when construction is undertaken and completed.)

The Harbors Division, Department of Transportation, of the State of Hawaii, the local cooperating agency, has reviewed the general plans of the eight proposed light-draft projects and, through the office of the Governor of Hawaii, has formally indicated full support of the proposed projects. Additionally, the Harbors Division has informally assured the district engineer that, as the representative of the State, it is willing and able to fulfill the necessary requirements of local cooperation as enumerated above and desires to undertake the projects upon Federal approval. In previous navigation projects with the Federal Government, the State has met its obligations in all respects and in some instances has contributed additional funds beyond the local cooperation requirements in the construction of these projects.

22. COORDINATION WITH OTHER AGENCIES

Many governmental agencies, private organizations, and individuals were contacted for advice and assistance in compiling this report. During the course of the studies, frequent conferences were held with representatives of the Harbors Division of the State of Hawaii's Department of Transportation, the local cooperating agency. The related plans and desires of the cooperating agency and other local interests were carefully considered in connection with site selection and developing project capacity and layout. In producing the recommended plans, their views were complied with to the greatest extent possible in keeping with sound engineering principles and the economic limits dictated by justification procedures.

The general plans for the eight projects were reviewed in draft form by the State's Harbors Division and the Department of Planning and Research, by the United States Fish and Wildlife Service, and by the United States Department of Health, Education, and Welfare. The complete letter comments of these agencies are reproduced in appendix D. These comments were given full consideration in finalizing this report. They are generally favorable and constitute full support of these projects. The Governor of Hawaii indicated his strong backing of all of the projects. The Fish and Wildlife Service stated the opinion that the general advantages that would accrue from the projects would far outweigh any disadvantages in the form of limited adverse effects on the local fish fauna and that the improvements would possibly improve the habitats for the nehu, an important tuna bait fish. The Department of Health, Education, and Welfare advised that the projects are not anticipated to cause adverse influences upon water supply, pollution control, and related factors in the local areas concerned except at Waianae, Oahu. There the harbor project would adversely affect existing sewage facilities. Relocation of the affected sewage outfall and treatment facilities would be accomplished by the cooperating agency as an agreed condition of local cooperation.

23. DISCUSSION

The potential harbor projects proposed for Federal construction in this report would be of a multi-functional nature in that they would meet overlapping public needs by serving a variety of purposes. They would not only be used as bases, launching sites, or operating foci for the recreational and commercial boats in their tributary areas, but they would also provide much needed harbor of refuge protection and service facilities for transient craft engaged in coastal cruising and interisland or transpacific operations. Six of the harbors would serve as home ports for both recreational and commercial fishing boats; two (the projects at Kailua, Oahu, and Reeds Bay (Hilo), Hawaii) would be utilized only by recreational craft because of the preponderantarequirement for recreational boat space. The harbor project at Hana would also

play a role in interisland freight transportation. Emphasis in selecting the basic system of 19 urgently-needed new harbor projects or improvements, in which the eight proposed projects would be integral units, has been placed upon meeting the present and anticipated requirements for harbor bases for recreational and fishing boats along the coasts of the major Hawaiian islands and on spacing harbors more equitably and strategically in terms of needs than in the past. The general plans of the eight proposed projects have been formulated on the basis of estimated space requirements at a scale of development which in each case would result in net construction costs to the United States in excess of the $200,000 limit authorized for small navigation projects under section 107 of Public Law 645, 86th Congress. The basic system of 19 public boat harbors proposed for the State of Hawaii on the basis of this survey is shown on plate 1 of this report as a suggested guide for initial planning purposes. This proposed system of harbor projects is not considered to represent a complete system capable upon construction of satisfying all of Hawaii's boating requirements over the next 50 years. It is, however, regarded as a planning foundation which, if realized, would satisfy the bulk of the State's estimated total requirements for light-draft vessel harbor space to the year 2015.

The relationship of a potential surface ferry system to State-wide requirements for light-draft harbors will be considered in the final report of this survey if concrete plans for such a system have been developed by the State by that time. It was not possible in this report to relate requirements for such a system to the specific design and economic evaluation of the harbor projects proposed herein because of lack of adequate firm information on the characteristics of craft to be employed and the nature of the ferry operation which might be forthcoming.

Development by local interests of the self-liquidating facilities in the berthing and onshore areas at each of the proposed projects could be accomplished on an incremental basis as public requirements dictate. Dredged spoil would be available in adequate quantity for the necessary fill required for all protective moles included in the project plans as well as for some of the land-side fill areas and interior moles which might be developed in conjunction with the self-liquidating facilities.

In 1962 the Harbors Division of the Department of Transportation, State of Hawaii, undertook an engineering model study of a preliminary plan developed by a private firm for a small-craft marina in the Kona region of the island of Hawaii. Should the State desire to undertake similar model studies as proposed in this report for the planned projects at Waianae, Oahu, and Hana, Maui, consideration should be given to allowing the local cooperating agency to conduct these model studies as contributed work towards the State's share of the project first costs.

The information called for by Senate Resolution 148, 85th Congress, adopted 28 January 1958, is appended to this report as attachment I.

24. CONCLUSIONS

The district engineer finds that the existing small-craft harbors in the State of Hawaii are able to accommodate satisfactorily less than 50 percent of the total actual demand for berthing space for water-based boats. Of the more than 3,500 craft based in harbors or along the coasts of the six major islands of the State, only approximately 1,500 can be considered safely based. Four of the 22 principal small-craft harbors in the State, which could be classed in 1961 as improved or partially improved, are strictly fair-weather ports. Less than half of the others provide adequate protection from severe storm conditions. Docking, berthing, launching, and service facilities are fully developed at only a few of the harbors. Furthermore, in the strategic sense from the standpoint of interisland cruising, the available public harbors for small craft are unsatisfactorily spaced along the coasts of the main islands. They are also inequitably located in terms of the overall population distribution. As a result, some coastal sectors of considerable length, or with significant numbers of residents, have no improved harbors whatsoever. In the Honolulu metropolitan area on Oahu, existing boating facilities were greatly overtaxed before the addition of the Keehi marina in 1962. The Ala Wai recreational boat harbor and Kewalo Basin in Honolulu for commercial craft remain at peak occupancy. Generally, the State development program has been unable to keep abreast of the rapidly increasing pressure for more harbor spaces.

Suitable natural harbors are scarce along the coasts of Hawaii, and there are few inland waters usable for boating. Consequently, the lack of a safe harbor has worked a definite hardship on some communities, particularly in rural areas where fishing for a livelihood or to supplement income is important to many local residents. A more general adverse effect on the State as a whole has been the retardation of the growth rate in recreational boating. Hawaii lags far behind the mainland states in recreational boat ownership, with less than 10 boats per 1,000 people as compared with the national average of over 40 boats per 1,000 population. In view of Hawaii's favorable climate and ocean location, it is a logical assumption that this discrepancy in the level of boating activity between Hawaii and the mainland stems in large measure from the inadequacy of small-craft facilities in the islands and the consequent limitation on boating opportunity. Since many boats are not sufficiently protected against storms by existing harbor facilities, and the distances to safe havens often make transfer of craft difficult, boat losses and damages in some localities run high. Monetary losses directly attributable to inadequate facilities for the State as a whole are conservatively estimated at over $275,000 per annum in late years. As a recent

example of such losses, a $40,000 charter boat and an $18,000 commercial fishing boat were totally wrecked in separate storms early in 1963 at Keauhou Bay in the South Kona area of Hawaii because of lack of an adequately sheltered harbor in that district. Losses of this nature have definitely deterred increased boat ownership in those areas most frequently affected. The added hazard to life and limb which results in some coastal sectors from inadequate shelter for small craft or from too widely spaced boat refuges cannot be appraised in tangible terms, but it is clearly a critical factor of public concern in Hawaii's present boating situation.

The district engineer therefore concludes that there is an urgent need in the State of Hawaii for an improved and expanded system of small-craft harbors to meet the present and forthcoming boating requirements of the people of Hawaii. He further concludes that Federal participation with the State of Hawaii in developing such a system of light-draft harbors is warranted and desirable in the public interest.

25. RECOMMENDATIONS

The district engineer recommends the adoption of Federal projects for light-draft navigation entailing the construction of small-boat harbors in the State of Hawaii at Hanalei Bay, Kauai; at Waianae, Heeia-Kea, Kailua, and Maunalua Bay, Oahu; at Lahaina and Hana, Maui; and at Reeds Bay (Hilo), Hawaii; all substantially in accordance with the general plans accompanying this report or as modified as may be advisable in the discretion of the Chief of Engineers, the features and estimated costs of which are summarized in table 18. The estimated total first cost for the eight harbor projects is $8,674,000.

He further recommends that construction of the navigation improvements cited at any of the localities named may be undertaken independently of the others whenever the necessary funds for a complete project become available and when local interests have given assurances satisfactory to the Secretary of the Army that they will (a) provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the projects and for aids to navigation upon the request of the Chief of Engineers, including suitable areas determined by the Chief of Engineers to be required in the general public interest for the initial and subsequent disposal of spoil, and also provide necessary retaining dikes, bulkheads, and embankments therefor or the costs of such retaining works; (b) provide and maintain without cost to the United States necessary berthing or mooring facilities and attendant utilities, including a public landing with suitable supply facilities open to all on equal terms, and additionally at Hana, Maui, provide and maintain an appropriate public terminal with whatever installations are deemed essential to serve the anticipated commercial transportation operations at that

Table 18
Recommended Improvements and Estimated Costs

Location	Recommended improvements	Corps of Engineers First cost of const.	Corps of Engineers Annual maint.	Local cash contribution Percent	Local cash contribution Est. amount
Hanalei Bay Kauai	An entrance and main access channel 1,800' long, 100' to 120' wide, 12' to 15' deep; a jetty 380' long; and 1,600' of channel and bank revetment.	$ 669,000	$ 2,000	48.1	$322,000
Waianae Oahu	A breakwater 1,350' long; a groin 175' long; an entrance channel 830' long, 150' wide, depth 15' to 17'; a main access channel 870' long, 100' to 150' wide, 12' to 15' deep.	1,794,000	12,000	48.0	861,000
Heeia-Kea Oahu	Three revetted moles with lengths of 1,450', 1,780', and 1,720'; a north access channel 570' long, 150' wide, and 12' deep; a central access channel 1,100' long, 200' wide and 12' deep; a south access channel 150' long, 150' to 280' wide, and 8' deep; plus removal of coral head.	808,000	5,000	49.4	399,000
Kailua Oahu	A turning basin of 120,000 sq. ft., 6' deep; and a main access channel 1,800' long, 100' to 150' wide, and 6' deep.	487,000	6,000	50.0	243,500
Maunalua Bay Oahu	An east revetted mole 2,900' long; a west revetted mole 1,950' long; an entrance channel 870' long, 200' wide, 15' to 20' deep; a widened channel section of 370,000 sq. ft., 15' deep.	1,023,000	8,500	49.9	510,000
Lahaina Maui	A revetted mole 620' long; offshore breakwater 950' long; turning basin and main access channel of 140,000 sq. ft.; entrance channel 515' long, 150' wide, 15' to 20' deep; and a wave absorber 180' long.	685,000	5,000	46.9	321,000
Hana, Maui	A breakwater 1,230' long.	1,839,000	15,000	8.7	160,000
Reeds Bay (Hilo) Hawaii	A breakwater 870' long; and entrance channel 880' long, 120' wide, and 12' deep.	496,000	4,000	50.0	248,000

harbor; (c) provide and maintain without cost to the United States depths in the berthing or mooring areas, and in the local access channels thereto, commensurate with the depths provided in the related project areas; (d) provide and maintain without cost to the United States all appropriate onshore structures, access roadways, parking areas, public restrooms, and boat launching ramps as necessary to insure a complete and adequate project; (e) accomplish without cost to the United States such utility, drainage, or other relocations or alterations as necessary for project purposes; and (f) contribute in cash, prior to construction of each project, a lump sum payment of the estimated amounts shown in table 18 expressed as a percentage of the estimated first cost of construction by the Corps of Engineers, the final contribution to be adjusted after actual costs have been determined.

The district engineer additionally recommends that, during advanced engineering and design, model test studies be conducted to determine the wave and surge characteristics which would result from the project features recommended for the harbors at Waianae, Oahu, and at Hana, Maui. The costs of such model studies are estimated at $40,000 and $38,000, respectively, and are included in the first costs for those projects.

The net first costs of these eight light-draft navigation projects to the United States, excluding the cost of navigational aids and after reimbursement by local interests of the contributed amounts indicated above, are now estimated at $347,000 for Hanalei Harbor, Kauai; $933,000 for Waianae Harbor, Oahu; $409,000 for Heeia-Kea Harbor, Oahu; $243,500 for Kailua Harbor, Oahu; $513,000 for Maunalua Bay Harbor, Oahu; $364,000 for Lahaina Harbor, Maui; $1,679,000 for Hana Harbor, Maui; and $248,000 for Reeds Bay (Hilo) Harbor, Hawaii.

D. G. WILLIAMS
Colonel, Corps of Engineers
District Engineer

[First endorsement]

PODGM (8 Mar 63)
SUBJECT: Interim Report on Survey of the Coasts of the Hawaiian Islands for Harbors for Light-draft Vessels

US Army Engineer Division, Pacific Ocean, Honolulu, Hawaii, 26 March 1963

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

I concur with the views and recommendations of the District Engineer. I further recommend that the construction of the Heeia-Kea Harbor, Oahu be done in two stages. The second stage, consisting of the revetted mole and main access channel of the north basin, should be deferred after completion of the south basins until the need therefor has become apparent.

Stephen E. Smith

STEPHEN E. SMITH
Colonel, Corps of Engineers
Division Engineer

U. S. ARMY ENGINEER DISTRICT, HONOLULU
CORPS OF ENGINEERS
HONOLULU, HAWAII

APPENDIX D

COORDINATION WITH OTHER AGENCIES

TO ACCOMPANY
INTERIM REPORT ON SURVEY
OF THE
COASTS OF THE HAWAIIAN ISLANDS
HARBORS FOR LIGHT-DRAFT VESSELS

FILE NO. _____

WILLIAM F. QUINN
GOVERNOR

MICHAEL M. MIYAKE
COMPTROLLER

STATE OF HAWAII
DEPARTMENT OF ACCOUNTING
AND GENERAL SERVICE
HONOLULU 10, HAWAII

Letter No.
2-3073.1

June 18, 1962

Colonel D. G. Williams
Corps of Engineers
U. S. Army Engineer District
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

In response to your POHGP letter dated June 6, 1962, please be advised that the Department of Accounting and General Services has no comments on the preliminary plans for the nine small-boat harbor projects which you are planning to recommend in your interim report covering proposed navigation improvements for light-draft vessels in Hawaii.

Very truly yours,

Michael M Miyake

MICHAEL M. MIYAKE
Comptroller, State of Hawaii

36-957 O-64—7

WILLIAM F. QUINN
GOVERNOR

FRANK LOMBARDI
DIRECTOR
PHILIP T. CHUN
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF PLANNING AND RESEARCH
426 QUEEN STREET
HONOLULU 13, HAWAII

Ref. No. DPR 7106

June 25, 1962

Colonel D. G. Williams
U.S. Army Corps of Engineers
Building 96
Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

In reply to your letter of 6 June 1962, reference POHGP, I wish to advise that our comments on the proposed nine harbors for light-draft vessels along the coasts of the Hawaiian Islands will be submitted to the State's Department of Transportation for inclusion in a single coordinated report to you from the State of Hawaii. This procedure will simplify the process of obtaining comments and will permit you to centralize your contact with the State in one agency, namely, the Division of Harbors in the Department of Transportation, on all matters relating to harbors and beaches.

Thank you for the opportunity of submitting comments on the proposed harbors. These projects have important effects on adjoining land uses and it is essential to be aware of their locations well in advance of possible construction so that conflicts can be eliminated.

I look upon small boat harbors as capital investment to beget land and economic development on the various islands. This should be borne in mind in your priorities. Mere "harbors of refuge" will not meet this state's economic development needs.

You will probably have a full report on this matter from our Department of Transportation in the near future.

Sincerely,

FRANK LOMBARDI
DIRECTOR

cc: Mr. Jess H. Walters
Mr. Tim Ho

UNITED STATES COAST GUARD

ADDRESS REPLY TO
COMMANDER
14th Coast Guard District
1347 Kapiolani Blvd.,
Honolulu 14, Hawaii

o
A1
Serial: 32114
June 25, 1962

From: Commander, Fourteenth Coast Guard District
To: District Engineer, U. S. Army Engineer District, Honolulu, Hawaii

Subj: Aids to Navigation for proposed Small Boat Harbors Project

Ref: (a) U. S. Army Corps of Engineers ltr POHGP dtd 28 May 1962

1. Reference (a) requested expenses involved in the establishment of subject aids to navigation. Enclosure (1) gives the estimated cost of establishment and annual maintenance for the aids to navigation as listed for the proposed projects. Enclosure (2), consisting of nine drawings of the various small boat harbor projects, show the proposed types and locations of the suggested aids to navigation.

2. In the interest of economy, the number of aids have been kept at the minimum considered necessary to provide the mariner with adequate service.

3. The proposed aids are essentially the same as those tentatively decided upon during the conference between Commander SCHARFF and Mr. KELLER and Mr. NAKOSHIMA of your staff on 25 May 1962. The few additions were considered necessary after further study.

GEORGE D. SYNON
Acting

Encl: (1) Establishment and maintenance costs for State proposed Small Boat Harbors
(2) Drawings of the various small boat harbor projects (9)

Copy to:
COMDT(OAN) (less Encl. (2))

ENCLOSURE (1) to CCGD14(o) ltr A1 ser 32114 dtd 25 June 1962

1. The following aids to navigation with the estimated cost of establishment and annual maintenance are considered the minimum needs in the respective areas to afford safe navigation. Locations for these aids are on enclosure (2).

	PROJECT	ESTABLISHMENT COST	MAINTENANCE COST(Annual)
a.	Kailua Bay, Oahu		
	Establish one 40' high shore light	$ 5,600	$ 300
b.	Kaneohe Bay, Oahu		
	Discontinue Heeia-Kea approach buoys 1 and 2. Establish two 5FE buoys	5,000	500
c.	Kahului Harbor, Maui		
	Replace Kahului Harbor buoy 4 with 6X20E(RR). Establish one breakwater light and one channel daybeacon	10,700	800
d.	Hana, Maui		
	Replace one 1/c Nun with 8X26E(RR). Establish one breakwater light and one 8X26E(RR) buoy	16,000	1,600
e.	Hilo Bay, Hawaii		
	Relocate and replace buoy 10 with 6X20E(RR). Establish one breakwater light and one channel daybeacon.	9,200	800
f.	Waianae, Oahu		
	Establish one breakwater light and one 8X26E(RR) buoy	9,400	900
g.	Hanalei Bay, Kauai		
	Establish one each breakwater light, channel daybeacon and 8X26E(RR) buoy	11,700	1,000
h.	Lahaina, Maui		
	Establish one each 8X26E(RR) buoy and breakwater light. Establish two 2/c buoys	13,100	1,300
i.	Maunalua Bay, Oahu		
	Establish one mole light and one 8X26E(RR) buoy. Establish two channel lights	18,200	1,300

CABLE ADDRESS
FISHWILD

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF COMMERCIAL FISHERIES
P. O. Box 3830, Honolulu 12, Hawaii

HAWAII AREA

ADDRESS ONLY
THE AREA DIRECTOR

June 25, 1962

District Engineer
U.S. Army Engineer District, Honolulu
Corps of Engineers
Building 96, Ft. Armstrong
Honolulu 13, Hawaii

Reference: POHGP

Dear Sir:

We have reviewed, in consultation with the State Fish and Game Division, your preliminary plans for the nine small-boat harbors to be located along the coasts of the Hawaiian Islands. This review was made in accordance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.). While it is true that the indicated dredging and construction work would certainly alter the existing physical environment and consequently have some effect on the fish fauna presently occupying those areas, it is our opinion that the advantages that will accrue from the proposed developments would far outweigh any disadvantages.

The proposed harbor developments would very likely stimulate sport and commercial fishing by providing harbor facilities for light-draft fishing vessels at favorable locations throughout the State. The dredging of channels would probably attract certain game species and other useful fishes into the areas. In particular, the dredging operations may improve the habitat and increase the local supply of the important tuna bait fish, the nehu (Stolephorus purpureus). In addition, if these dredged areas as well as the proposed moles are made accessible, they will provide additional recreational fishing for the general public.

Sincerely yours,

John C. Marr
Area Director

36-957 O-64—8

DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE
REGIONAL OFFICE
PUBLIC HEALTH SERVICE
447 Federal Office Building
San Francisco 2, California

July 20, 1962

AIR MAIL

Colonel D. G. Williams
District Engineer
U. S. Army Engineer District, Honolulu
Corps of Engineers
Building 96, Ft. Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

In accordance with procedures outlined by the Federal Inter-agency Committee on Water Resources, we have reviewed jointly with the State of Hawaii Department of Health preliminary plans for nine harbors for small craft as forwarded to these offices by letter dated June 7, 1962.

No adverse effects on water supply, water pollution control, general sanitation conditions, and vector conditions are anticipated by constructing the nine proposed projects.

General Plan, Waianae, Oahu, RH-100/8.6 has an adverse effect on existing municipal waste treatment and disposal. Although the community of Waianae is presently conducting engineering studies for relocation of existing treatment facilities and outfall, present Waianae treatment facilities and outfall are located on the proposed harbor site. Adequate measures should be provided to relocate this facility prior to construction. No other adverse effects are anticipated.

We appreciate the opportunity to review these projects. Any future revisions in work plans and construction should be forwarded to these offices in quadruplicate for review and comment.

Sincerely yours,

William B. Schreeder
Chief, Water Quality Section
Water Supply & Pollution Control

cc: B. J. McMorrow

WILLIAM F. QUINN
GOVERNOR

STATE OF HAWAII
EXECUTIVE CHAMBERS
HONOLULU

JUL 30 1962

Colonel D. G. Williams
District Engineer
U.S. Army Engineer District, Honolulu
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Subject: Proposed Small Boat Harbors Most Urgently Needed by State of Hawaii

Dear Colonel Williams:

Reference is made to your letter POHGP dated June 6, 1962, requesting our review and comments relative to Hawaii's nine most urgently needed small boat harbors.

We thank you for inviting several of the State agencies to comment on the proposed small boat harbors which are required for recreational and commercial boating now and over the next 50 years. As noted, additional harbors are most urgently needed to provide refuge havens for small crafts during storms.

Inasmuch as developments of the small boat harbors affect the economy of the areas and the Islands where they are to be constructed, the importance of proper priority to be assigned to each of the proposed harbors is of prime consideration. The State concurs in the priorities you have selected.

We would like to recommend that you also obtain the views and comments of the Counties, if this has not been done, so as to avoid any duplication of effort or divergent planning. The State, as you are fully aware, has always been willing to coordinate its program with the U.S. Engineers insofar as is practicable.

The following brief comments on each of the small boat harbors reflect the coordinated thinking of the various State agencies which you have contacted. In general, the small boat harbors as planned by your office are in conformity with developments proposed by the State for each site. We have noted a few exceptions in the following comments.

1. Hanalei, Kauai. The State feels that the small boat harbor should be located on the east side of Hanalei Bay where urban development is proposed. The location of the proposed harbor in Hanalei River incorporating the old channel as a harbor basin, is preferred. The realignment of the river channel will reduce silting and flooding and the river can be used as an entrance channel. We request that you re-study the harbor location.

2. Lahaina, Maui. There is no conflict with Lahaina restoration plan and inasmuch as the location of the proposed small boat harbor conforms with the State General Plan, the State concurs in your preliminary plan.

3. Reeds Bay, Hawaii. Although the State General Plan does not call for a small boat harbor at this location, the State has no reason for disapproval.

4. Heeia-kea (Kaneohe), Oahu. The State envisions extensive development of the small boat harbor toward Kahuku from the existing improvements, thus, making the location conform with that of the State General Plan.

5. Hana, Maui. The location of the proposed small boat harbor conforms with that of the State and therefore your preliminary plan is satisfactory.

6. Pokai Bay, Oahu. The general location of the proposed small boat harbor is satisfactory. However, decided differences are noted in the breakwaters and rock sizes from those specified on plans submitted by the State's consultants, Belt, Collins & Associates. Even if the plans submitted by the consultants are economically not feasible according to U.S.E.D. standards, the State earnestly requests that ways and means be found so as to be able to obtain Federal participation for the construction of the necessary breakwaters and for dredging the entrance channel.

7. Maunalua Bay, Oahu. The location of the proposed small boat harbor conforms with that of the State General Plan. The State wants a larger area set aside for park purposes between Kalanianaole Highway and the proposed parking site for cars and trailers.

8. Kailua, Oahu (Kawainui). Although the State has not shown any small boat harbor in the Kawainui Swamp, nonetheless, a harbor has been previously considered for somewhere in the above location. Inasmuch as there are no conflicting factors affecting the location as proposed by the U.S.E.D., the State tentatively concurs in the above site, pending final determination by the City Council regarding future developments contemplated for the Kawainui Swamp.

9. Kahului, Maui. The removal of the proposed small boat harbor into the State's Disposal Area, as originally planned, is requested. The property adjoining the Disposal Area, not being State owned, would pose several problems.

In addition to the nine small boat harbors listed above, we appreciate that you have under authority of Section 107 of Public Law 645, 86th Congress, requested approval to undertake detailed engineering studies on the proposed small boat harbors at Manele Bay, Lanai; Maalaea, Maui; Haleiwa, Oahu; and Nawiliwili, Kauai.

It certainly is very gratifying to note that through the efforts of your office, an allotment up to $200,000, the very first of such Federal funds as far as small boat harbors are concerned, will become available probably the latter part of this year for the construction of the breakwaters and for dredging of the approach channel and basin at Manele, Lanai. It is hoped that the allotments for the three remaining small boat harbors will be forthcoming in the not too distant future.

In conjunction with all the proposed small boat harbor projects mentioned above, we feel that the plans of the Division of State Parks should be discussed at this time because they are either directly or indirectly related to small boat harbor development.

On Kauai. Limited recreational development is expected on the Na Pali coast while funds will be expended at the Milolii and Nualolo Kai beach areas for contemplated improvements to the existing entrance channels into the reefed anchorages. Furthermore, development of small boat harbor facilities on the right bank of the Wailua River just upstream from the highway bridge is planned to enhance recreational opportunities.

On Oahu. Kahana Valley park development is expected to take place with the acquisition of lands bordering Kahana Bay. There is the possibility that boating facilities might be increased with future demand.

On Maui. A major State park development is envisioned for Honokawai, west Maui. It should be noted that the proposed small boat harbor project at Lahaina would work very well with the park program.

On Hawaii. The State has plans for a small boat harbor at Honokahau, Kona, together with a large park development. Although no funds were appropriated by the last Legislature, it is hoped that the contemplated developments will become realities in the not too distant future.

Presently, there is a launching ramp in the State Park at the Waiakea Mill Pond, a public fishing area. At this writing it is uncertain whether there will be any future development in this area.

Other improvements proposed by the State during the next six years are as listed in the Capital Improvement Program, a copy of which you undoubtedly already have in your possession.

Thank you again for your usual fine cooperation with the State of Hawaii in this matter. Please do not hesitate to refer any further questions to the Harbors Division of the Department of Transportation if you so desire.

Sincerely,

William F. Quinn

WILLIAM F. QUINN
GOVERNOR OF HAWAII

cc Depts. of Land & Nat. Res., Plan. & Res., Transportation
Sen. Fong, Sen. Long, Rep. Inouye

STATE OF HAWAII
EXECUTIVE CHAMBERS
HONOLULU

WILLIAM F. QUINN
GOVERNOR

September 6, 1962

Colonel D. G. Williams
District Engineer
U.S. Army Engineer District, Honolulu
Bldg. 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

Thank you for your letter of August 16, 1962 relative to small boat harbors and particularly to the proposed harbors at Hanalei, Kauai and at Pokai Bay, Oahu.

We recognize the engineering and cost disadvantages of the Hanalei River site as opposed to a site on the westside of the bay. We are not prepared to endorse the latter site at this time since all our previous planning was based on the construction of a small boat harbor in Hanalei River.

We are of the opinion that it would be better to concentrate all recreational and other activities at the east side of the bay so as to preserve the natural state of the west side. Furthermore, it was our thought that the small boat harbor could be constructed in conjunction with a flood control project for Hanalei River. We will, however, review our plans for the area in light of your choice of the westerly site and your statement that the Hanalei River site would show an unfavorable benefit-cost ratio.

We are in agreement with you that the most economical design for the Pokai small boat harbor should be followed and that the breakwater should be adequately designed.

The preliminary plan prepared by your office and that prepared by the State are compatible with the General Plan for the area. They differ somewhat in their layout but it is quite possible that both plans offer features which would be incorporated in the final design.

We are therefore prepared to endorse your design for the Pokai small boat harbor (which you refer to as the Waianae Harbor) as a preliminary plan.

You and your staff have been most cooperative in this study and we appreciate this example of fine relationship between the Federal government and the State of Hawaii.

Sincerely,

William F. Quinn

WILLIAM F. QUINN
GOVERNOR OF HAWAII

cc Land & Nat. Res.
Plan. & Res.
Transportation

WILLIAM F. QUINN
GOVERNOR

STATE OF HAWAII
EXECUTIVE CHAMBERS
HONOLULU

October 3, 1962

Colonel Donald G. Williams
District Engineer
U.S. Army Engineer District, Honolulu
Bldg. 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

This is in reply to your letter POHGP of September 18, 1962 concerning the inclusion of the Hanalei and Reeds Bay small boat harbor projects in your report on the most urgently needed harbors in Hawaii.

We recognize the urgency of early completion of your report and the advantages to the State of placing this matter before Congress at an early date. The Hanalei small boat harbor location which you have suggested will require a complete revision of our planning for the area. We suggest therefore that this harbor be excluded from your first report.

We feel very strongly that the Reeds Bay small boat harbor should be included, although there has been no especially strong expression of local support for the project. We believe that there is a need for the project and that the support will be developed in time to assist the passage of the authorization bill in Congress.

Again, let me express my fine appreciation in the manner in which the Corps of Engineers is handling this important project.

Sincerely,

William F. Quinn

WILLIAM F. QUINN
GOVERNOR OF HAWAII

cc Transportation
Planning & Research

WILLIAM F. QUINN
GOVERNOR

STATE OF HAWAII
EXECUTIVE CHAMBERS
HONOLULU

November 20, 1962

Colonel Donald G. Williams
District Engineer
U.S. Army Engineer District, Honolulu
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Dear Colonel Williams:

I am most grateful for the decision you have made to include Reeds Bay, Hawaii, and Hanalei River mouth on Kauai as sites for urgently needed small boat harbors as set forth in your letter of October 22, 1962.

We appreciate that additional work will have to be undertaken by the Corps of Engineers on the Hanalei site and that the resulting change will delay the submission of your report.

I would also like to thank you personally for the excellent cooperation my administration has received from the Honolulu District over the past five years.

Sincerely,

William F. Quinn

WILLIAM F. QUINN
GOVERNOR OF HAWAII

cc Planning & Research
Transportation

KAIPO F. KAUKA
DEPUTY DIRECTOR

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
869 PUNCHBOWL ST., HONOLULU 13, HAWAII

HD 991

February 7, 1963

Colonel D. G. Williams
District Engineer
U. S. Army Engineer District, Honolulu
Building 96, Fort Armstrong
Honolulu 13, Hawaii

Re: Preliminary Plans for Certain Proposed Small Boat Harbors

Dear Colonel Williams:

We have reviewed your preliminary plans for the proposed small boat harbors listed below and recommend a minimum 20-foot channel depth for each of them. We refer to harbors at:

Waianae, Oahu (Kaneilio Point)
Hanalei Bay, Kauai
Maunalua Bay, Oahu
Hana, Maui
Lahaina, Maui

The above recommendations are based on our study of the sites, discussions with local boatmen and knowledge gained from experience in designing numerous State harbors for small craft. We have, for instance, found it necessary to redredge 2200 ft. of the offshore end of the Ala Wai channel from 22 feet of depth to 35 feet.

All of the harbors mentioned above are ideally located as havens of refuge in addition to meeting other harbor needs. Our Hawaiian waters can be very rough during storms due to the tremendous stretch of water across the Pacific Ocean. Safe harbors are vitally important at these times and, obviously, they must have channel depths which would be adequate for passage during rough weather.

Yours very truly,

MELVIN E. LEPINE
Manager and Chief Engineer
Harbors Division
Department of Transportation

MEL:mp
cc: T. Mori; Capt. W. S. Latham; Capt. E. H. Stein

ATTACHMENT I
TO
INTERIM REPORT ON SURVEY
OF THE
COASTS OF THE HAWAIIAN ISLANDS
HARBORS FOR LIGHT-DRAFT VESSELS

Information Called for by
Senate Resolution 148, 85th Congress
Adopted 28 January 1958

1. PROJECT DESCRIPTION AND ECONOMIC LIFE

The Federal portions of the eight recommended boat harbors would be limited to construction and maintenance of the protective structures and the general navigation channels which would include entrance and/or main access channels and, in some cases, maneuvering areas or turning basins. The recommended features vary with each project and are identified in the following tabulation. Construction and maintenance of the berthing or mooring areas and facilities, including local access channels, and the provision of all necessary onshore installations and facilities would be accomplished by local interests as self-liquidating items not included in the Federal projects. The economic life used in the evaluation of each project is 50 years.

Location	Recommended improvements
Hanalei Bay Kauai	An entrance and main access channel 1,800' long, 100' to 120' wide, 12' to 15' deep; a jetty 380' long; and 1,600' of channel and bank revetment.
Waianae Oahu	A breakwater 1,350' long; a groin 175' long; an entrance channel 830' long, 150' wide, depth 15' to 17'; a main access channel 870' long, 100' to 150' wide, 12' to 15' deep.
Heeia-Kea Oahu	Three revetted moles with lengths of 1,450', 1,780', and 1,720'; a north access channel 570' long, 150' wide, and 12' deep; a south access channel 150' long, 150' to 280' wide, and 8' deep; plus removal of coral head.
Kailua Oahu	A turning basin of 120,000 sq. ft., 6' deep; and a main access channel 1,800' long, 100' to 150' wide; and 6' deep.
Maunalua Bay Oahu	An east revetted mole 2,900' long; a west revetted mole 1,950' long; an entrance channel 870' long, 200' wide, 15' to 20' deep; a widened channel section of 370,000 sq. ft. 15' deep.

Location	Recommended improvements
Lahaina Maui	A revetted mole 620' long; offshore breakwater 950' long; turning basin and main access channel of 140,000 sq. ft.; entrance channel 515' long, 150' wide, 15' to 20' deep; and a wave absorber 180' long.
Hana, Maui	A breakwater 1,230' long.
Reeds Bay (Hilo) Hawaii	A breakwater 870' long; and entrance channel 880' long, 120' wide, and 12' deep.

2. PROJECT COSTS

The estimated net first costs of construction by the Corps of Engineers (which excludes the costs of navigational aids to be provided by the Coast Guard) and the annual maintenance costs to the Corps of Engineers are shown in the following breakdown as the Federal costs for each project. The non-Federal costs shown include the costs of obtaining the necessary lands, easements, and rights-of-way, of making any required relocations, and the local cash contribution based on the percentage of anticipated local benefits. No operation or replacement costs are involved. The cost estimates include allowances of 20 percent for contingencies and reflect the price levels prevailing in Hawaii in November 1962.

	Federal			
Project	Construction cost	Annual maintenance	Non-Federal	Total first cost of project
Island of Kauai:				
Hanalei Bay	$ 347,000	$ 2,000	$530,000	$ 887,000
Island of Oahu:				
Waianae	933,000	12,000	934,000	1,877,000
Heeia-Kea	409,000	5,000	437,000	851,000
Kailua	243,500	6,000	485,500	735,000
Maunalua Bay	513,000	8,500	657,000	1,118,000
Island of Maui:				
Lahaina	364,000	5,000	344,000	721,000
Hana	1,679,000	15,000	189,000	1,884,000
Island of Hawaii:				
Reeds Bay (Hilo)	248,000	4,000	274,000	531,000

3. BENEFIT-COST RATIOS

The average annual costs for the assumed 50-year economic life of each project were computed using an interest rate of 3 percent for the Federal and non-Federal capital investments. The total average annual tangible benefits expected to accrue to each light-draft navigation project, compared with the estimated annual capital costs, are shown below with the resulting benefit-cost ratios. Amortization of project costs over a greater period than a 50-year project life is not considered appropriate in determining project feasibility nor would it result in change in scope of the projects or the basis for cost-sharing arrangements. Projection of the boat population of the State, upon which the scale of individual projects is based, over a longer period with any reasonable degree of accuracy is not considered feasible.

Project	Total average annual benefits	Total average annual costs	Benefit-cost ratio
Island of Kauai			
Hanalei Bay Harbor	$ 47,000	$36,500	1.3 to 1
Island of Oahu			
Waianae Harbor	96,000	85,000	1.1 to 1
Heeia-Kea Harbor	211,000	38,100	5.5 to 1
Kailua Harbor	53,000	34,600	1.5 to 1
Maunalua Bay Harbor	232,000	54,600	4.2 to 1
Island of Maui			
Lahaina Harbor	47,000	32,900	1.3 to 1
Hana Harbor	107,000	88,200	1.2 to 1
Island of Hawaii			
Reeds Bay (Hilo) Harbor	53,000	24,600	2.2 to 1

4. INTANGIBLE PROJECT EFFECTS

Storm damages to the existing small-craft fleet in Hawaii which can be attributed to inadequate harbor protection have been substantial in past years. These losses frequently involve threat to life and limb. As a factor in preventing or reducing loss of life and bodily injury, the storm refuge and emergency value of the recommended projects would result in significant intangible benefits to the boating public. This protective or safety aspect of the proposed facilities is clearly a major element in the assessment of project need, particularly because of the effects of the vast open seas surrounding Hawaii on the local boating situation.

5. FEASIBILITY OF PROVIDING FOR FUTURE NEEDS

The design for each of the recommended projects is based upon satisfaction of the projected needs for safe harbor space of the boat population of the local tributary areas concerned through the year 2010.

6. ALLOCATION OF COSTS

Allocation of costs between project purposes is not applicable since only one water use, navigation, is involved.

7. EXTENT OF INTEREST IN PROJECTS

The recommended projects have the full support of the State of Hawaii and are generally considered to be urgently needed by the boating public. The local cooperating agency of the State, designated by the Governor of Hawaii, is the Harbors Division of the Department of Transportation. The conditions of required local cooperation are contained in section 21 of the main report and are repeated in the recommendations. Coordination would be effected directly between the offices of the district engineer and the Harbors Division, and the Federal cost of such participation is included in the cost items shown in table 13 of the main report under the heading of supervision and administration.

8. REPAYMENT SCHEDULES

The construction cost of the general navigation facilities, comprising the recommended features of each project, would be apportioned between the United States and the State of Hawaii in direct and identical proportion to the expected general and local benefits. No periodic repayment schedules are applicable since, in accordance with item (f) of the required conditions of local cooperation, local interest would be required to contribute in cash, prior to construction of each project, a lump sum payment expressed as a percentage of the Federal first cost (exclusive of aids to navigation), the final contribution to be adjusted after actual costs have been determined. The presently estimated amounts of the local cash contribution and the percentage of the project construction costs they represent are as follows.

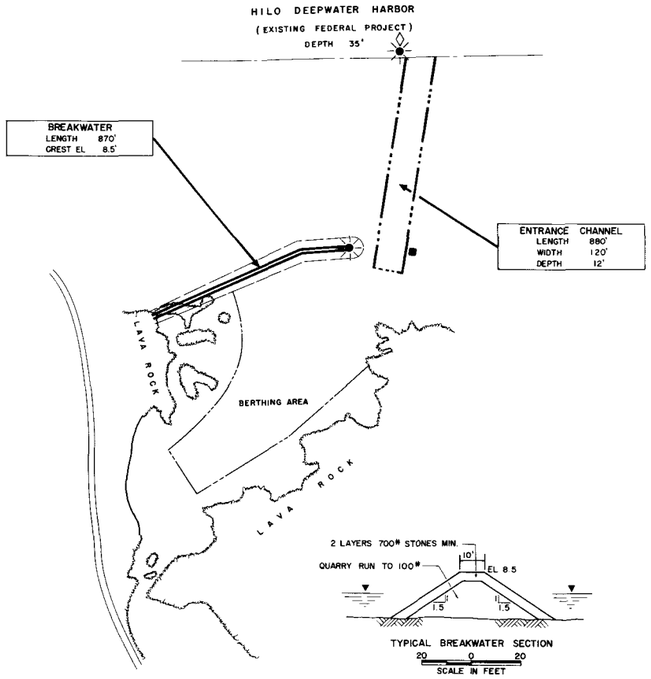
Project	Estimated local cash contribution	Percent of Federal construction cost
Island of Kauai:		
Hanalei Bay Harbor	$322,000	48.1
Island of Oahu:		
Waianae Harbor	861,000	48.0
Heeia-Kea Harbor	399,000	49.4
Kailua Harbor	243,500	50.0
Maunalua Bay Harbor	510,000	49.9
Island of Maui:		
Lahaina Harbor	321,000	46.9
Hana Harbor	160,000	8.7
Island of Hawaii:		
Reeds Bay (Hilo) Harbor	248,000	50.0

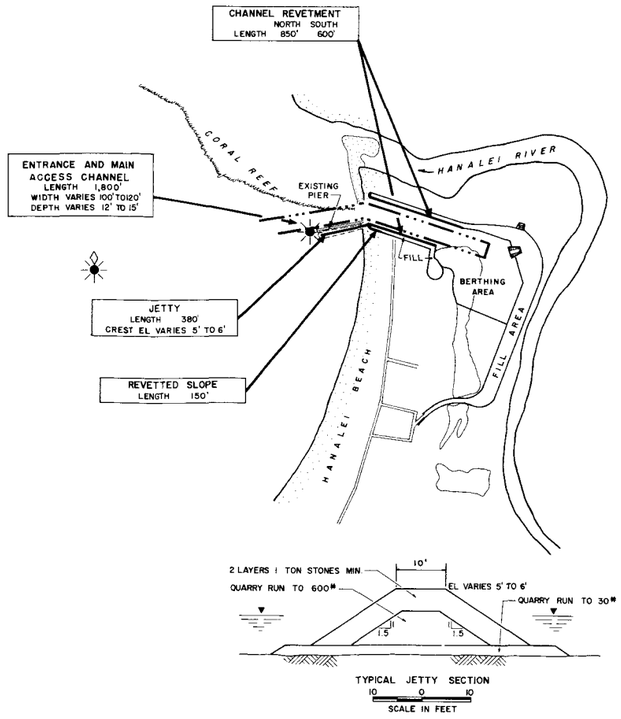
9. PROJECT EFFECTS ON STATE AND LOCAL GOVERNMENTS

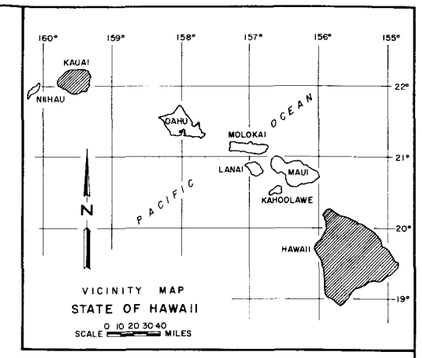
The increased cost of State government services in operating and maintaining the self-liquidating portions of the eight recommended boat harbors would be offset in part by the berthing fees charged to harbor users. Definite taxation advantages are expected to accrue to the State and county governments. All the projects are expected to have a positive beneficial effect on business activities in the communities concerned, and, in most of the areas, probably would result in an increase in local property values. The new harbors are expected to cause a considerable increase in the rate of growth of the State's boat population which has been retarded, in comparison with mainland trends, because of inadequate harbor facilities. This growth should not only result in increased sales and servicing of boats, motors, and other marine equipment but also cause expanded sales of related recreational equipment and sporting goods. In addition, increased sales of gasoline, diesel fuel, and lubricants would result in greater tax revenues for the State. A very minor amount of tax revenue would be lost to the county governments as a result of small acreages of private lands at some of the sites reverting to State ownership, but these losses would, in all probability, be greatly offset by the tax gains involved.

CORPS OF ENGINEERS

U. S. ARMY

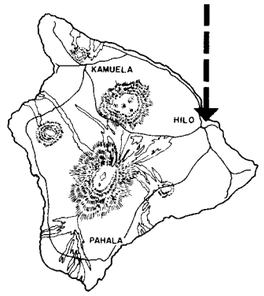






REEDS BAY (HILO)

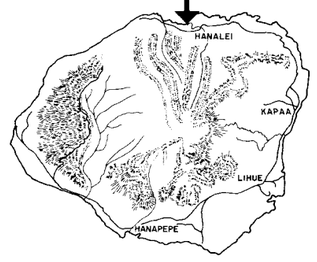
200 0 200 400
SCALE IN FEET



LOCATION MAP
ISLAND OF HAWAII
0 5 10 15
SCALE IN MILES

HANALEI BAY

400 0 400 800
SCALE IN FEET



LOCATION MAP
ISLAND OF KAUAI
0 1 2 3 4 5
SCALE IN MILES

N

LEGEND

- REEF
- HARBOR STRUCTURES
- TOE OF STRUCTURES
- DREDGING PROJECT LIMITS
- EXISTING COASTLINE
- EXISTING ROADS
- RECOMMENDED FEDERAL PROJECT FEATURES IDENTIFIED IN BOXES
- RECOMMENDED NAVIGATIONAL AIDS
- PROPOSED LAUNCHING RAMP SITE

COASTS OF HAWAIIAN ISLANDS — HAWAII

INTERIM REPORT ON SURVEY OF HARBORS FOR LIGHT-DRAFT VESSELS

GENERAL PLANS
ISLANDS OF KAUAI AND HAWAII

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, HONOLULU

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

APPROVED RECOMMENDED: CHIEF, ENGINEERING DIVISION

APPROVED: COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: T.S.
TRACED: T.S.
CHECKED: K.J.V.

TO ACCOMPANY REPORT DATED 8 MARCH 1963

FILE NO. RH 100/7.7

PLATE 7

36-957 O-64 (Face p. 102) No. 1

CORPS OF ENGINEERS

U. S. ARMY

KANEOHE BAY

REVETTED MOLES

	NORTH	CENTRAL	SOUTH
LENGTH	1,450	1,780	1,720
CREST EL	8'	8'	8'

MAIN ACCESS CHANNEL

	NORTH	CENTRAL	SOUTH
LENGTH	570'	1,100'	150'
WIDTH	150'	200'	150' - 280'
DEPTH	12'	12'	8'

CORAL HEAD
TO BE REMOVED TO EL -12'

BERTHING AREA

KAMEHAMEHA HIGHWAY

CORAL REEF

EXISTING MOLES AND BASIN

2 LAYERS 600# STONES MIN.
QUARRY RUN TO 100#

TYPICAL REVETTED MOLE SECTION
SCALE IN FEET

VICINITY MAP
STATE OF HAWAII
SCALE 0 10 20 30 40 MILES

KAUAI, NIIHAU, OAHU, MOLOKAI, LANAI, MAUI, KAHOOLAWE, HAWAII, PACIFIC OCEAN

HEEIA - KEA
SCALE IN FEET

KAPOHO POINT

KAILUA BAY

RESIDENTIAL AREA

KALAHEO AVENUE

ONEAWA CHANNEL

ONEAWA STREET

AREA OF KAILUA TOWN

KAILUA ROAD

KAILUA
SCALE IN FEET

POKAI BAY

EXISTING BREAKWATER

KANEILIO POINT

MIKILUA RD

SEWER LINE
EXISTING
NEW

GLENMORGER RD

POKAI STREET

PARKING AND ON-SHORE FACILITIES

BREAKWATER
LENGTH 1,350'
CREST EL VARIES 6' TO 17'

MAIN ACCESS CHANNEL
LENGTH 870'
DEPTH VARIES 12' TO 15'
WIDTH VARIES 100' TO 150'

GROIN
LENGTH 175'
CREST EL 8'

ENTRANCE CHANNEL
LENGTH 830'
WIDTH 150'
DEPTH VARIES 15' TO 17'

2 LAYERS 7 TON STONES
EL VARIES 6' TO 17'
QUARRY RUN TO 1 TON

TYPICAL BREAKWATER SECTION
SCALE IN FEET

WAIANAE
SCALE IN FEET

LEGEND
- REEF
- HARBOR STRUCTURES
- TOE OF STRUCTURES
- DREDGING PROJECT LIMITS
- EXISTING COASTLINE
- EXISTING ROADS
- RECOMMENDED FEDERAL PROJECT FEATURES IDENTIFIED IN BOXES
- RECOMMENDED NAVIGATIONAL AIDS
- PROPOSED LAUNCHING RAMP SITE

WAHIAWA

WAIANAE

KALIHI

HONOLULU

LOCATION MAP
ISLAND OF OAHU
SCALE IN MILES

TO PRIVATE MARINA

KAL ANIANAOLE HIGHWAY

KULIOUOU PARK

KULIOUOU STREAM

FILL AREA

EXISTING CHANNEL

WEST REVETTED MOLE
LENGTH 1,950
CREST EL 9'

BERTHING AREA

ENTRANCE CHANNEL
LENGTH 870'
WIDTH 200'
DEPTH VARIES 15' TO 20'

CORAL REEF

MAUNALUA BAY
SCALE IN FEET

TURNING BASIN
AREA 120,000 SQ FT
DEPTH 6'

MAIN ACCESS CHANNEL
LENGTH 1,800'
WIDTH VARIES 100' TO 150'
DEPTH 6'

EAST REVETTED MOLE
LENGTH 2,900'
CREST EL 9'

2 LAYERS 0.65 TON STONES MIN.
QUARRY RUN TO 200#

TYPICAL REVETTED MOLE SECTION
SCALE IN FEET

EXISTING DRAINAGE DITCH

KAWAINUI SWAMP

℄ PROPOSED FLOOD CONTROL LEVEE

COASTS OF HAWAIIAN ISLANDS — HAWAII

INTERIM REPORT ON SURVEY OF HARBORS FOR LIGHT-DRAFT VESSELS

GENERAL PLANS
ISLAND OF OAHU
SCALE AS SHOWN

U S ARMY ENGINEER DISTRICT, HONOLULU

SUBMITTED: CHIEF PLANNING AND REPORTS BRANCH

APPROVAL RECOMMENDED: CHIEF ENGINEERING DIVISION

APPROVED: COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN T.Y.S.
TRACED T.Y.S.
CHECKED M.P.K.

TO ACCOMPANY REPORT DATED 8 MARCH 1963

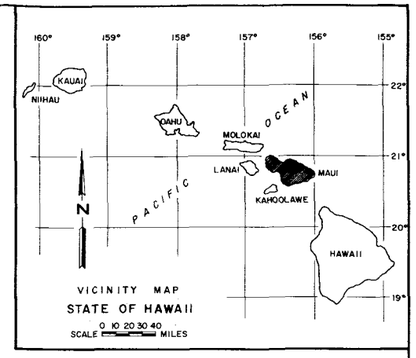
RH 100/7.8

PLATE 8

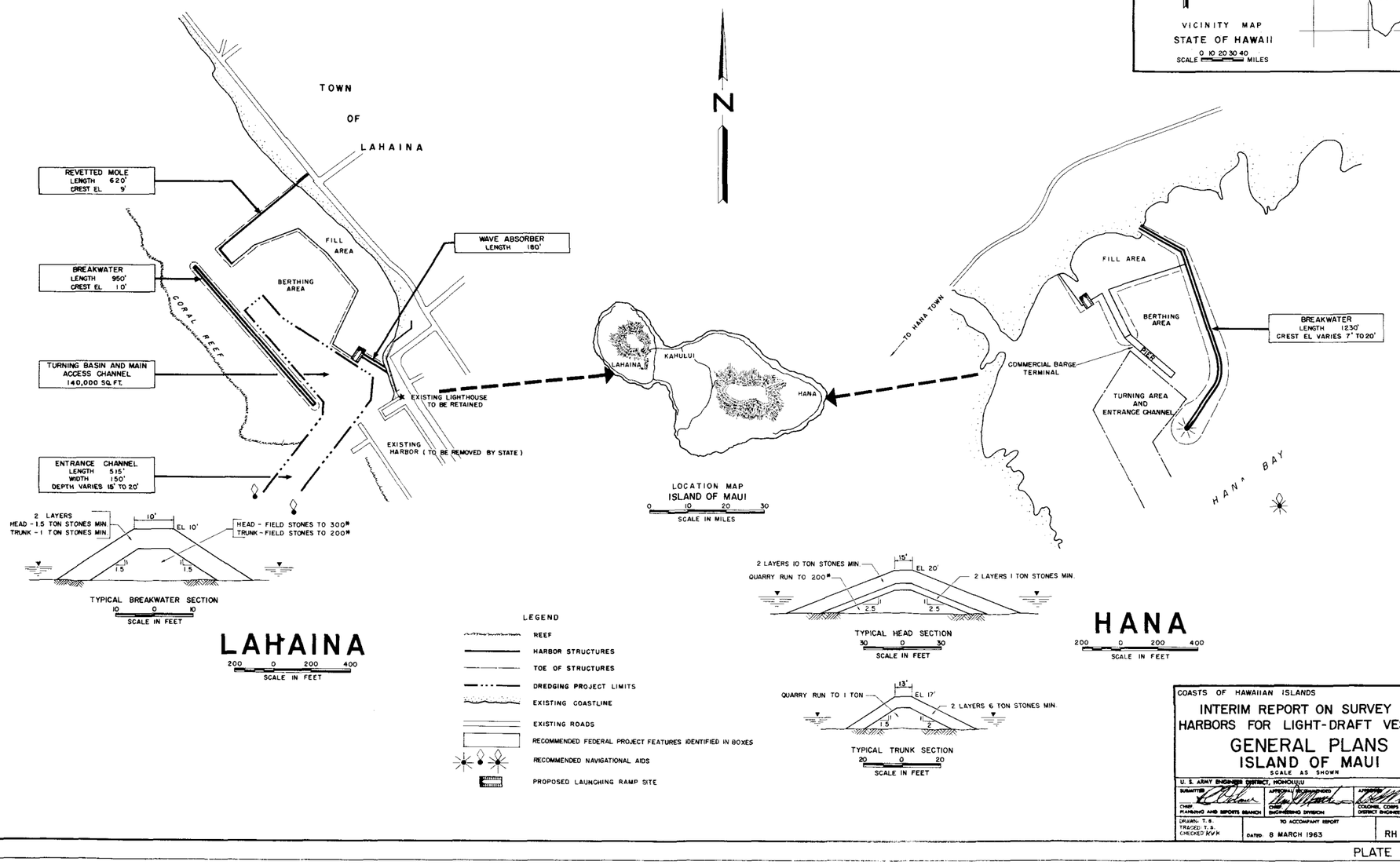
36-957 O-64 (Face p. 102) No. 2

CORPS OF ENGINEERS

U. S. ARMY



VICINITY MAP
STATE OF HAWAII
0 10 20 30 40
SCALE MILES



COASTS OF HAWAIIAN ISLANDS HAWAII

INTERIM REPORT ON SURVEY OF HARBORS FOR LIGHT-DRAFT VESSELS

GENERAL PLANS
ISLAND OF MAUI

SCALE AS SHOWN

U. S. ARMY ENGINEER DISTRICT, HONOLULU

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION

APPROVED: COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN: T. S.
TRACED: T. S.
CHECKED: K.V.K.

TO ACCOMPANY REPORT DATED 8 MARCH 1963

FILE NO. RH 100/7.9

PLATE 9

36-957 O-64 (Face p. 102) No. 3